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SOLID WASTE MANAGEMENT
IN THE FOOD PROCESSING INDUSTRY

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Detailed information and data are presented regarding food and non-food residuals generated in the processing of canned and frozen fruits, vegetables, specialty items, sea foods, pickles, and dehydrated fruits and vegetables. The industry is discussed in general, and processing procedures for 28 major commodities are outlined. The quantities of residuals, in-plant handling methods, on-site storage facilities, disposal methods, and by-products are described. Environmental problems associated with solid waste management and costs incurred in handling, treatment, and disposal are enumerated. Alternative processes and technological changes that affect waste generation are discussed.

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SUMMARY

This survey covered the generation and management of residuals from the processing of canned and frozen fruits and vegetables, specialties, seafoods, pickles, and dehydrated fruits and vegetables. The industry that processes these foods commercially in the United States is referred to in this report as the ''surveyed industry.''

A questionnaire was developed to elicit much of the desired information. The form was distributed to food processors who are members of the National Canners Association or of the American Frozen Food Institute. A total of 421 returns were received. Additional information was obtained to supplement the questionnaire data during follow-up site visits which were made to 229 processing plants.

Due to the wide variety of commodities handled by food processors and the numerous processing operations employed, only the major commodities within each product class (fruit, vegetable, seafood, specialities) have been selected for detailed discussion. Process flows and descriptions of residuals and their sources for 28 individual commodities are included.

The surveyed industry used about 33.5 million tons of raw products (weight as delivered to the processor) in a year and generated about 10 million tons (wet weight) of solid residuals, of which 7.3 million were used as by-products, 1.7 million were disposed of as solid waste, 0.3 million were disposed of in a liquid medium, and 1.0 million were unaccounted for. In addition, more than 0.6 million tons of non-food residuals (wrapping materials, containers, and other wood, metal, paper, and plastic) were accumulated at processing plants; 0.2 million were reused. Detailed data are given for nine regions of the United States (Tables 34, A1, A2, and A3), for months of the year (Tables 32, A1, and A3), for nine methods of disposal (Tables 33, 34, A2, and A3), and for 35 types of commodities (Tables 32, 33, A1, A2, and A3).

The methods commonly employed to convey residuals from the processing area of the plant include belts and other dry conveying systems, flumes and pumping systems, containers, and floor gutters. The method utilized for a specific residual is generally dictated by its physical characteristics, as determined by the operation which creates the residual. The on-site storage facilities which are provided include stockpiles, containers, trucks, and elevated hoppers. Several plants discharge the residuals with the liquid waste. The numbers and characteristics of solid waste disposal sites are summarized (Tables 47 through 57). The costs of solid and liquid residuals handling, treatment and disposal are estimated (Tables 59 through 64).

The most frequent of five summarized types of problems associated with solid residuals at the plant site was with

insects. At landfill disposal sites, insects caused the most problems, followed by rodents and odors. Where wastes were spread on land and where they were burned, odors caused the most problems.

Alternate processes and technological changes which may reduce the generation of solid and liquid residuals include equipment and process modifications, use of dry conveying systems, and in-field preprocessing operations. Research programs, directed both toward diminishing the quantity of residuals which are created and toward methods for improved disposal and/or increased utilization, are needed.

Tabulations of detailed information developed during this survey and definitions of specialized terms are contained in the appendices.

SOLID WASTE MANAGEMENT IN THE FOOD PROCESSING INDUSTRY

INTRODUCTION

The program described in this report was initiated to develop detailed information regarding (1) the quantity of solid residuals annually generated by a segment of the food processing industry, (2) the characteristics of the residual materials, and (3) the methods of solid residuals management employed by the industry, including in-plant handling, on-site storage, and ultimate disposal or utilization of the various materials.

Only scant and sketchy information of the above nature had heretofore been accumulated. For this reason, very few references were utilized during the project. Where information from outside sources has been incorporated into this report, appropriate citations have been included.

The developed information and data have been organized into several sections, each covering a different aspect of the program objectives. Each section has been intentionally organized to be somewhat independent, thereby necessitating a degree of redundancy. Wherever practical, repetition of information has been avoided by references to appropriate sections for specific details.

In lieu of an index, the Table of Contents has been expanded to include all titles and headings used in this report. The reader is therefore directed to the Table of Contents for the location of specific information.

DESCRIPTION OF THE INDUSTRY

The Surveyed Industry

SIC Codes and Regions. The products included in this report are canned and frozen fruits, vegetables, specialties, seafoods, and pickles, and dehydrated fruits and vegetables, manufactured in the United States. Specifically the following Standard Industrial Classification codes (1*) are included:

2031	Canned and cured seafoods
2032	Canned specialties (soup, baby food, dried beans, etc.)
2033	Canned fruits and vegetables
2034	Dehydrated food products (excluding fruits that are conventionally farm dried such as raisins and prunes)
2035	Pickles (but not sauces or salad dressings; Census statistics reduced by two-thirds to exclude omissions)
2036	Frozen packaged fish (but not fresh seafoods or those marketed in a similar manner; Census statistics reduced by two-thirds to exclude omissions).
2037	Frozen fruits and vegetables

The reductions for SIC 2035 and 2036 were estimated by the authors from Census of Manufactures data (2).

The production of and residuals from about 30 to 35 types of commodities have been given in detail in this report. These are the ones processed in largest quantities, producing most residuals, and with the most data. Miscellaneous vegetables, fruit and seafood include all of these kinds of products not separately listed. Specialties includes an enormous range of formulated products, and almost all of the commodity designations include numerous raw product varieties and pack styles. For example, several varieties of both freestone and clingstone peaches are processed and fruits may be whole, pitted, peeled, unpeeled, halved, sliced, diced, spiced, pureed, or concentrated, and alone or mixed with other fruits. Syrup of a range of sugar concentrations may be added. Canning, freezing, or dehydrating procedures and container sizes add further variety.

Data for five classes of products - fruit, tomato, vegetable, seafood, and specialties - are given separately in many parts of this report. Tomatoes were chosen to help illustrate how certain industry characteristics vary between specific and general product classes; they were selected because they make up a large pack in several regions and because extensive data on tomatoes were available.

Many of the data were treated separately for nine regions of the United States, defined as follows for this study:

---

*Reference numbers are in parentheses; see Appendix A.

New England:	Maine, Vermont, New Hampshire, Connecticut, Massachusetts, Rhode Island
Mid Atlantic:	New York, New Jersey, Pennsylvania
South Atlantic:	West Virginia, Virginia, Maryland, Delaware, North and South Carolina, Georgia, Florida
North Central:	North and South Dakota, Nebraska, Kansas, Minnesota, Iowa, Missouri, Wisconsin, Illinois, Indiana, Michigan, Ohio
South Central:	Texas, Oklahoma, Arkansas, Louisiana, Kentucky, Tennessee, Mississippi, Alabama
Mountain:	Montana, Wyoming, Utah, Colorado, New Mexico
North West:	Washington, Oregon, Idaho
Alaska:	
South West:	California, Nevada, Arizona, Hawaii

Comparison to Other Industries. Table 1 lists information from the 1967 Census of Manufactures (2). Data cover all industries, food and kindred products, and the surveyed industry and its components. In general, the food and kindred products industries were about a tenth of all manufacturing and the surveyed industry was more than one one-hundredth of all manufacturing in the United States in number of plants and employees and in value added by manufacture. The surveyed industry had relatively fewer small plants than the other sectors and such ratios as employees, manhours, value added, and new capital expenditures per plant reflect this. Wages per manhour and manhours per production worker were lower in the surveyed than in the other industries. The value of year-end inventories was relatively much greater in the surveyed industry than in the others, as expected because of highly seasonal operation.

TABLE 1

GENERAL STATISTICS, CENSUS OF MANUFACTURES

	1967												1963	
	establishments		all employees		production workers									
	total	with 20 or more empl.	total 1000	pay-roll $ mil.	total 1000	man-hours mil.	wages $mil.	value added by mfg. $mil.	cost of . mat'l $mil.	value of shipm $mil.	new cap. expend $mil.	yr. end inven-tory $mil.	all empl. 1000	value added by mfg $ mil.
all industries	311000	107000	19300	132000	14000	27900	81500	262000	299000	558000	21400	84300	17000	192000
20 food and kindred	32600	13600	1650	10100	1120	2270	6080	26600	57700	84100	1730	7740	1640	21800
2031 can.. seafood	319	160	16	68	14	23	54	180	341	520	9	129	17	175
2032 can.. special.	176	84	27	158	22	45	115	602	762	1360	28	249	25	541
2033 can. fr. veg't.	1230	737	101	480	90	176	379	1420	2090	3500	102	1090	102	1030
2034 dehydr. foods	179	81	11	59	10	18	46	179	268	442	15	121	9	116
2035x1/3 pickles	176	61	6	33	5	10	23	93	169	261	5	47	6	83
2036x1/3 froz. fish	166	81	7	29	6	11	20	55	131	189	3	25	7	40
2037 froz. fr. &veg't.	610	365	66	302	57	112	284	781	1340	2120	78	380	52	550
total surveyed ind.	2850	1570	234	1130	204	395	871	3310	5100	8400	240	2040	218	2540

Figures rounded after adding

Quantities and Costs of Materials. The 1967 Census of Manufactures (3) listed tonnages and costs of the products used by the surveyed industry. The total quantities derived from the Census were (figures rounded, x1000 tons):

Fresh fruit & veget.	Seafood	Sugar	Fats & Oils	Dried Fruit	Meat	Wheat Flour	Poultry	Conc. Fruit
20,460	720	810	180	400	210	230	100	30

The quantities estimated for this survey were somewhat greater, as detailed below. Part, but not all, of the difference is because the survey quantities were for 1968 and the Census quantities for 1967. Especially large packs of some products were put up in 1968. Estimated total costs of ''materials'' from one of the Census tabulations were $5,095 million, explicitly including the costs of power and freight. The $4,630 million costs used here were derived from another Census report, on materials consumed. In Table 2 costs based on the latter Census data were extrapolated to the tonnages from the 1968 survey. The figures were rounded after adding.

TABLE 2
1967 CENSUS AND ESTIMATED 1968 TONNAGES AND COSTS

	1967 Census			1968 Survey	
	Product, 1000 Tons	Cost, $million	$per ton	Product, 1000 Tons	Estim. Cost, $million
Fresh fruit & vegetables	20,460	$1,310	$ 64	32,500	$2,100
Seafood	720	260	370	930	340
Processed food	1,970	660	330	3,000	1,000
Containers	----	1,160	----	----	1,700
Other materials	----	1,240	----	----	1,840
Total	23,140	$4,630	----	36,500	$7,000

Other data on product quantities and on waste handling and disposal costs are in following parts of this report.

Materials Balance. An approximate materials balance for the surveyed industry as a whole was estimated from figures in this report and from unpublished data collected by the National Canners Association. Raw food products (including preprocessed foods and ingredients), water, and packaging materials were included, but not agricultural wastes left in the field, lubricants, fuel, lye, detergents, paint, or other minor materials. The excluded materials contribute traces to the various waste streams. All of the following data are in approximate millions of tons per year. The raw food product input, 36, is dispersed as processed food, 21; by-products such as animal feed, 7; water vapor from concentration operations (often condensed into the liquid waste stream), 5; wasted solids, 2; and unaccounted for (including shrinkage between weighing and processing, dissolved substances in liquid waste, and other losses), 1. The water input, 400, is used in the canned food as brine or sirup, 5; and an unknown quantity, probably only a few million tons, is lost to evaporation; the quantity of wasted liquid is within the rounding error of the input quantity, 400. Packaging materials input, about 5, is used in containers, cases, and labels, 4; diverted to by-products, 0.2; and disposed of as solid waste, 0.4.

Proportions of Canned and Frozen Products. Table 3 lists the percentages of raw tons used in canning, freezing, and other processing covered in this survey (figures rounded). ''Other'' processing includes pickling, dehydrating (but not dried fruits), and a few other processes. Estimates are not given for some commodities that are included in other parts of this report. Large percentages of citrus are frozen and of pineapple are canned; fin fish are mostly canned.

Production Trends. Table 4 lists U.S. per capita consumption of the principal processed fruits, vegetables and seafoods, compiled by the Economic Research Service of the U.S. Department of Agriculture and the Bureau of Commercial Fisheries of the U.S. Department of the Interior and summarized in the *Almanac of the Canning, Freezing, Preserving Industries* (4). The figures have been rounded after adding. These are final rather than raw product weights and they do not include certain military purchases, net exports, dehydrated foods, frozen seafoods, or speciality products. Since the production of both canned and frozen specialties is increasing rapidly, projections from the data in the table are likely to be conservative.

Preserving

Extending the trend of the tabled totals indicates a 15% increase in per capita consumption of the principal processed foods between 1968 and 1980. Extension of the U.S. population trend from the 1940 through 1970 censuses also indicates a 15% increase, 1968 to 1980. An increase in processed foods consumption of more than 30% is therefore to be expected. Total raw tons of the products covered in this report would then be about 45 million per year by 1980, and about 13 millions tons of residuals would be generated annually, assuming no change in processing methods.

TABLE 3
PERCENTAGES OF RAW TONNAGE BY PROCESSING METHOD

Product	% Canned	% Frozen	% Other	Product	% Canned	% Frozen	% Other
Asparagus	71	29		Pumpkin, Squash	80	20	
Bean, Lima	28	72		Tomato	100		
Bean, Snap	77	23		Apple	56	11	33
Beet	100			Apricot	92	7	
Broc, Caul, Sprouts		100		Cherry	32	45	23
Cabbage	100			Peach	92	5	2
Carrot	36	64		Pear	100		
Corn	72	28		Plum, Prune	96	4	
Greens, Spinach	52	48		Bean, Dry	100		
Pea	61	39		Pickle			100
Potato, White	6	62	32				

TABLE 4
U. S. PER CAPITA CONSUMPTION*

Approx. Year	Canned Fishery Products	Canned Veget.	Canned Fruits	Canned Fruit Juice	Frozen Veget.	Frozen Fruits & Juices	Total
1945	4	43	14	11	2	2	77
1950	5	42	22	13	3	4	90
1955	4	43	21	13	7	9	97
1960	4	44	23	13	10	9	103
1965	4	49	23	11	14	8	110
1968	4	52	23	13	18	9	119

*pounds per year, rounded

The Surveyed Sample

Size of Companies. The sizes of the companies in the survey and the sizes of all companies in the industry were compared by reference to the Directory of the Canning, Freezing, Preserving Industries (5). Ten of the companies returning questionnaires for the survey could not be found in the Directory and are omitted from Table 5. The Directory classifies companies in broad size categories, but not individual plants, so the following comparisons are by company. Multiplant companies commonly returned questionnaires for most but not all of their plants if they were in the survey at all. The Directory lists about 1600 companies; the survey included 201 companies that were listed in the Directory.

TABLE 5
PERCENTAGES OF COMPANIES BY SIZE

Size Class*	AAAA	AAA	AA	A	B	C	D	Size Unknown	Total
% of all companies in Directory	5	5	8	11	11	17	12	31	--
% of companies in survey	13	5	14	13	11	17	5	21	--
% of size class in survey	33	15	22	14	13	13	6	8	13

*Class AAAA is the largest, class D the smallest, measured by cases (canning) or weight (freezing) of product output.

The survey included companies of all sizes, and the number of survey companies in most size classes was a fairly constant proportion of the total number of companies in that size class. However, the largest companies (estimated annual output over 50,000 tons) were considerably over-represented in the survey; and AA companies (about 10-25,000 tons) were somewhat over-represented. The smallest companies (less than 1,000 tons) were under-represented, but the combined production of all the companies in this size class was probably less than 1% of the total. In addition, the proportion of survey companies whose size was not listed in the Directory (because not known) was smaller than that for all listed companies. Possibly smaller companies are also under-represented in the Directory (which lists fewer than the 2,850 plans given by the U.S. Census of Manufactures). If this is true, the smallest companies are even more neglected in the survey, but their small output still minimizes the effects of the discrepancy.

Proportion of Plants and Production. Figures from the 1967 Census of Manufactures (3) total about 2,850 plants in the categories covered by this survey. Questionnaires were submitted by 421 plants, about 15% of the total number.

Of the 33.5 million tons of raw product used by the whole industry, about 39% were accounted for by the survey plants. This percentage varied widely among products and among regions of the country.

The Census gives about 1,280 plants with fewer than 20 employees out of about 2,850 total plants in the surveyed industry, or 45%. Since the average quantity of raw product per employee in the industry is approximately 150 tons, these plants handle roughly 3,000 tons or less of raw product per year. Their combined raw product must, therefore, be considerably less than 1,280 times 3,000, which equals about 3.8 million tons, and could be estimated at less than 10% of the nation's total. The under-representation of these small plants in the survey (about one questionnaire out of six) again does not appear to be serious in most of this report's estimates.

The bias in the sample toward larger plants must have affected the figures on by-products including by-product income; see discussions later in this report. The plant size bias would also affect data on the costs of waste handling and disposal if they were used directly. The costs and by-product incomes estimated in this report were therefore adjusted to compensate for plant size.

Other factors in this survey found to be related to plant size were the type of screens for separating solids from liquid waste streams, the facilities for on-site accumulation of solid residuals, the ownership (or operation) of solid waste disposal sites, some of the problems with insects, rodents and odors at solid waste disposal sites, and the seasonality of operations. The effects of plant size on these factors are discussed elsewhere in this report. The effects of the plant size bias are minimized by the fact that the larger plants over-represented in the sample also handled larger proportions of the product tonnage.

Commodities and Processes. Types of products and of processes represented by the survey questionnaires are in Table 6 in percentages of plants; for example, 21% of the New England plants processed fruits and 93% of the New England plants used the canning process.

The columns in Table 6 may add to more than 100% because some plants handled more than one type of product or employed more than one process. Data were lacking for some plants (for example, tomato plants total less than 100%). The entry, 3%, under tomato and opposite the freeze process does not imply that tomatoes were frozen, but only that 3% of the plants which processed tomatoes also froze some product, and similarly for other entries.

TABLE 6
PRODUCT CLASSES AND PROCESSES (PERCENTAGES)

	New Eng.	Mid Atl.	South Atl.	North Cent.	South Cent.	Mount-ain	North West	Alas-ka	South West	Total
Fruit	21	19	25	14	11	9	45	0	62	30
Tomato	0	23	6	16	0	45	0	0	28	15
Vegetable	7	65	31	62	32	64	69	0	43	50
Seafood	50	2	6	0	32	0	18	100	2	13
Specialty	21	21	33	25	42	18	6	0	13	18
Can	93	86	75	87	84	100	55	82	72	77
Freeze	43	21	47	25	3	18	68	32	30	36
Dehydrate	0	2	11	0	5	0	8	0	7	4
Raw,fresh	7	2	0	0	0	0	3	0	0	1
Salt,smoke	0	0	0	0	0	0	1	5	0	0+
Pickle	0	0	6	1	0	9	0	0	1	1

	Fruit	Tomato	Vegetable	Seafood	Specialty
Can	73	93	68	83	75
Freeze	41	3	32	45	32
Dehydrate	5	1	4	4	5
Raw,fresh	0	0	0	9	0
Salt,smoke	0	0	0	2	0
Pickle	1	1	1	0	5

Proportion of Raw Product Tonnages. Table 7 lists for each of 35 products or product classes and of nine regions the estimated total raw tons per year used by the industry and the raw tons represented by the survey sample. The figures were rounded after calculating the percentage of total raw tons in the survey. Preprocessed foods such as sugar are omitted.

The products with the lowest percentage representation in the sample include white potato and citrus, both with very large tonnages in the sample; and mushroom, clam, and shrimp, all three relatively small packs. Apple, dry bean, pickle, and tuna and miscellaneous seafood are products with moderate to large packs but low representation in the sample. The Western and North Central regions of the United States are the ones best represented in the survey sample.

For each product and region data on such factors as residual tonnages, their disposal, and their production per month were extrapolated to cover the whole industry. The effect of a relatively small sample is therefore merely a decreased precision in the extrapolation. Since an over-estimate of one detail (of, say, residual tons disposed of by a particular method in a particular area) can compensate for an under-estimate of another, the product, region, monthly, and disposal method totals are expected to be more precise than are the detailed figures.

TABLE 7
RAW TONS IN SURVEY SAMPLE

Product	Total Tons*	Sample Tons*	% In Sample
Asparagus	120	67	56
Bean, lima	120	70	58
Bean, snap	630	325	52
Beet	270	126	46
Broccoli, sprouts, cauliflower	260	158	61
Cabbage	230	104	45
Carrot	280	188	67
Corn	2,480	1,291	52
Greens, spinach	240	115	48
Mushroom	67	13	19
Pea	580	318	55
Potato, white	3,570	918	26
Pumpkin, squash	220	130	60
Tomato	7,000	3,731	53
Vegetable, misc.	1,220	380	31
Apple	1,050	146	14
Apricot	120	71	59
Berry	200	62	31
Cherry	190	56	30
Citrus	7,800	1,395	18
Fruit, misc.	150	87	58
Olive	85	70	82
Peach	1,100	688	63
Pear	410	264	64
Pineapple	900	331	37
Plum, prune	27	20	75
Bean, dry	230	46	20
Pickle	560	49	9
Specialty	2,500	1,781	71
Clam, scallop	90	9	10
Oyster	20	10	50
Crab	30	16	55
Shrimp	120	9	7
Salmon	120	44	37
Sardine	26	14	52
Tuna, misc. seafood	520	42	8

TABLE 7 · Continued

Region	Total Tons*	Sample Tons*	% In Sample
New England	980	98	10
Mid Atlantic	2,060	498	24
South Atlantic	8,320	1,394	17
North Central	5,890	2,916	50
South Central	1,220	266	22
Mountain	240	102	43
North West	4,310	1,889	44
Alaska	160	55	34
South West	10,310	5,927	58
Total	33,490	13,144	39

*x1000 tons per year, rounded

Plant Sizes by Raw Product Tonnage. The percentages of plants in the survey are listed by annual raw product tonnage within regions and product classes in Table 8. The raw product tonnage is as delivered at the plant; corn is weighed in the husk, and peas are nearly everywhere removed from the pod, for example. A plant packing two or more product classes was tallied according to its tonnage of each product class in each appropriate column. The average raw tons per plant is also listed.

South West plants averaged by far the largest in the survey, followed by South Atlantic, North Central and North West plants. Tomato plants were twice the average size and seafood plants were much smaller than average.

As a very approximate comparison, Table 9 lists the percentages of plants in the size ranges and the average tons per plant by product class as estimated for the entire industry in the costs section of this report. The precision of these estimates is not known, but the method by which they were derived could have introduced large errors.

TABLE 8
SURVEY PLANT SIZES IN PERCENTAGES OF PLANTS AND TONS PER YEAR

Annual raw tons (1000)	New Eng.	Mid Atl.	South Atl.	North Cent.	South Cent.	Mountain	North West	Alaska	South West	Total
0- 1	15	8	10	3	26	0	2	30	2	7
1- 5	62	26	20	11	26	64	15	65	18	22
5- 25	15	44	37	50	32	36	51	5	22	38
25-100	8	23	10	32	16	0	28	0	33	25
100-200	0	0	13	1	0	0	3	0	18	6
200+	0	0	10	2	0	0	2	0	6	3
Average per plant (1000)	7	12	39	28	14	9	27	3	59	31

	Fruit	Tomato	Vegetable	Seafood	Specialty
0- 1	2	2	1	24	10
1- 5	17	14	12	67	18
5- 25	39	24	52	7	37
25-100	26	31	30	2	30
100-200	10	22	3	0	2
200+	6	7	1	0	3
Average per plant (1000)	13	64	9	3	31

TABLE 9
APPROXIMATE U.S. PLANT SIZES

Annual raw tons (1000)	Fruit	Tomato	Vegetable	Seafood	Specialty
0- 1	10	7	9	43	51
1- 5	43	51	54	50	33
5- 25	29	20	31	3	8
25-100	14	14	4	3	8
100-200	3	7	1	0	5
200+	1	2	0	0	1
Average per plant (1000)	18	24	9	4	14

Plant Sizes by Tons Per Hour. Another measure of plant size is the tons of raw product processed per hour. The measure is imprecise because some plants operated two or three shifts per day at peak seasons and because some surveyed plants did not report the figure. Furthermore, in this listing (Table 10) averages were within commodity only; a plant reporting two or more commodities was entered separately under each of them. As noted elsewhere, the surveyed plants were larger than average, but this relationship may not be true for each commodity.

TABLE 10
TONS PER HOUR BY COMMODITY

Product	Average Tons/Hour	Product	Average Tons/Hour
Asparagus	6	Apple	9
Bean, lima	6	Apricot	15
Bean, snap	8	Berry	5
Beet	10	Cherry	8
Broc., cauli., sprout	8	Citrus	34
Cabbage	14	Fruit, misc.	9
Carrot	7	Olive	4
Corn	29	Peach	28
Mushroom	3	Pear	14
Pea	11	Plum, prune	5
Potato, white	11	Crab	2
Pumpkin, squash	16	Shrimp	2
Spinach, greens	9	Salmon	12
Tomato	69	Sardine	6
Vegetables, misc.	5	Tuna, misc.seafood	10
Bean, dry	3		
Pickle	10		

Of the products not listed, pineapple is generally packed in very large plants and clams and oysters in medium or small plants; specialty plants vary from very small to very large. Average plant capacities ranged widely for the same commodity among regions.

Plant Characteristics. Other data on the surveyed plants were in the questionnaires, as detailed below.

Location. The surveyed plants reported their locations as listed in Table 11 by percentage of plants; some plants reported more than one type of location.

Only 28% of the plants were located in an agricultural setting, a percentage that varied widely among regions and among product classes. Almost two-thirds of the plants were located within 0.3 miles of a residential development. The proportion of plants so located was especially high in the Mountain, New England, and North Central states and its minimum, in the South West states, was more than 50%. Product classes varied less than regions with respect to the nearest residence, but more seafood and specialty plants than the others were at least a mile away. Very few plants were as much as five miles from a residential development.

TABLE 11
PLANT LOCATIONS

Type of Location	New Eng.	Mid Atl.	South Atl.	North Cent.	South Cent.	Mount-ain	North West	Alas-ka	South West	Total
Agricult.	0	42	31	37	11	27	27	(5*)	25	28
Industr.	50	28	31	38	26	45	39	27	46	38
Commerc'l	14	21	33	16	42	18	28	41	30	16
Resident.	50	49	53	54	58	36	38	27	36	45
Miles 0	15	35	29	40	41	56	29	37	29	34
to .1-.3	69	27	29	36	24	33	29	26	25	31
resi-.4-.9	0	11	13	9	6	0	12	5	11	10
dence 1-4	15	24	23	14	29	11	27	26	34	24
5+	0	3	6	1	0	0	3	5	0	2

	Fruit	Tomato	Vegetable	Seafood	Specialty
Agricult.	24	33	32	4	16
Industr.	35	29	35	32	44
Commerc'l	27	28	18	36	27
Resident.	37	42	43	38	47
Miles 0	36	35	35	36	28
to .1-.3	33	38	35	29	32
resi-.4-.9	10	5	12	4	7
dence 1-4	18	20	17	29	32
5+	3	2	1	2	1

*forest

During the site visits, the distances from 133 Mountain, North West and South West plants to the nearest ''open land'' were estimated. ''Open land'' excluded rugged terrain unsuitable for waste disposal or treatment as well as built-up areas.

Approximate miles to open land	less than 1/2	1/2-1	1-2	2-5	more than 5
Percent of plants	36	21	18	17	8

(Plants farther from open land were more likely to use city treatment and less likely to operate their own treatment systems for liquid waste.)

Age. The ages of the surveyed plants are shown in Table 12 by the years the plant had been at its current site and the year of the last major expansion (percentages of plants).

TABLE 12
PLANT AGES

		New Eng.	Mid Atl.	South Atl.	North Cent.	South Cent.	Mont-ain	North West	Alas-ka	South West	Total
Years	0- 9	8	9	9	9	16	0	17	30	14	13
at	10-19	8	9	12	5	5	0	11	10	9	8
site	20-39	8	34	50	16	53	27	49	25	34	33
	40-59	54	34	21	50	21	45	18	10	36	34
	60+	23	14	9	20	5	27	5	25	6	13
Year	'65-'69	46	55	65	62	68	50	63	85	60	62
last	'60-'64	8	25	12	22	5	20	21	5	20	19
expan	'50-'59	8	8	18	11	16	10	9	10	12	11
sion	'50-	38	12	6	5	11	20	7	0	8	8

		Fruit	Tomato	Vegetable	Seafood	Specialty
Years	0- 9	9	9	10	17	14
at	10-19	8	0	7	15	13
site	20-39	40	30	32	27	29
	40-59	34	46	41	23	30
	60+	9	16	11	19	13
Year	'65-'69	52	61	65	63	67
last	'60-'64	23	17	22	7	16
expan	'50-'59	14	15	7	15	10
sion	'50-	10	7	7	15	7

The surveyed plants averaged a few decades old. A large majority of them in the New England, North Central and Mountain regions were at least 40 years old; plants in the other regions were younger, with similar averages but with different age distributions. Tomato plants were older than other product plants on the average; seafood plants had the highest percentage of both very recent and very old plants.

Expansion. More than 60% of all the plants had undergone a major expansion in the previous five years. New England plants averaged the longest time since a major expansion and Alaska plants the shortest. Plants packing different products did not vary much in this respect.

A majority of the plants (57%) had no current plans for expansion; this percentage varied from 48% in the Mid Atlantic to 80% in the Alaska regions, and from 41% by specialty plants to 62% by seafood plants. Overall, 6% of the plants expected to move, discontinue operations or reduce output. The balance, 37% of the plants, expected to increase their production, mostly within a year or two. Taking into account those planning no change or a decrease, the average planned change was an increase of about 10% of current production. Specialty plants expected the largest increases.

Operating Season. The months per year during which the plants operated varied widely among regions, products and processing methods, as shown in Table 13 (percentages of plants).

TABLE 13
OPERATING SEASONS

Operating Months/ Year	New Eng.	Mid Atl.	South Atl.	North Cent.	South Cent.	Mountain	North West	Alaska	South West	Total
1- 2	23	0	11	5	0	0	3	28	2	5
3- 4	0	16	4	41	6	64	20	39	33	28
5- 6	8	24	15	24	0	36	32	11	16	21
7- 8	23	8	18	10	18	0	14	6	17	13
9-10	0	24	15	1	12	0	15	6	8	9
11-12	46	27	37	19	65	0	17	11	23	24

	Fruit	Tomato	Vegetable	Seafood	Specialty	Can Only	Can & Freeze	Freeze Only	Any Dehdr.
1- 2	5	7	2	11	0	6	6	1	0
3- 4	21	52	24	16	0	37	12	12	0
5- 6	32	18	30	7	9	23	14	21	21
7- 8	16	8	13	20	7	9	14	22	29
9-10	11	8	12	13	4	7	14	12	7
11-12	15	7	19	33	80	18	41	31	43

''Any dehdr.'' means a plant that dehydrated some products, whether or not it also used other processes; ''can & freeze'' means these processes only. A few plants that used other processes (pickling, salting, etc.) were omitted in Table 13.

The average number of operating months per year was about six overall, with peaks at both 3-4 and 11-12 months. Alaska, Mountain and North Central plants averaged the shortest seasons; South Central and Mid and South Atlantic plants, the longest. New England had relatively high percentages of plants with 1-2 and with 11-12 operating months. Tomato plants had the shortest average seasons among product classes (the figures for tomato plants with long seasons do not mean that tomatoes were canned for this many months, but only that some tomato plants were operating on some product for the indicated time; similarly for other products and processes). Other specific commodity plants (such as peaches or corn) would also have had short seasons if they had been tallied separately. Specialty plants had by far the longest seasons, as expected. Seafoods also averaged fairly long seasons in spite of the very short season in Alaska. Freezing operations lasted longer than canning operations, and plants that had both averaged even longer seasons, about the same as dehydration plants.

Operating months per year varied some with plant size (as measured by the total tons of raw product received). The smallest plants (1000 tons or less) had either very short or very long operating seasons and the largest plants (over 200,000 tons) mostly had long seasons. However, the only trend across all six of the plant size categories was a decrease in 1- or 2-month seasons with increasing plant size; 21, 5, 3, 1, 0 and 0% of the plants of successively larger size operated for 1 or 2 months per year.

Seasonal operations, requiring that a whole year's residual materials be disposed of in a short time, severely complicate food processing waste problems. Residuals handling facilities must be large enough for peak loads but are idle much of the time. Outlets such as for animal feed are often not available because the supply of residuals is irregular through the year; food wastes generally cannot be stored without expensive pretreatment.

SURVEY PROCEDURES

Introduction

To elicit the desired information regarding the generation of residual materials and the management of these solid wastes by the food processing industry, a two-phase program was implemented. The first phase entailed the drafting and distribution of a questionnaire to develop information of a general nature, as well as specifics of production and residuals quantities. Site visits to selected processing plants comprised the second phase of the program. Detailed information to supplement the questionnaire data was accumulated during these site visits. (The questionnaire and site visit forms used during the program are in Appendix C.) These phases are described below.

Questionnaires

Questionnaire Form. The questionnaire requested the information outlined below.

- General Information
  - Plant Classification: processes conducted, age and location of plant.
  - Raw products processed: list of raw products, tonnages (delivered weight) by month, percent recovery (yield).
- Solid Waste Information
  - Sources and description: itemized listing of unit operations which generate residuals, description of residual materials.
  - In-plant waste handling systems: provisions for transporting residuals from the processing areas.
  - Quantity of solid waste: tons or cubic yards of residuals generated per product or source.
  - Current disposal method: disposal method, by-products manufactured, identification of waste hauler.
  - On-site accumulation and storage: provisions for solid-liquid separation, on-site residuals storage facilities, environmental problems (leaching, seepage, insects, rodents, and odors) at storage site, out-of-pocket expenses for waste hauling, incineration.
  - Disposal site information: method (landfill, spread, other), size, ownership and operator, type of land, waste materials received, frequency of use and cover, costs, environmental problems.
  - Waste utilization: materials utilized, by-products manufactured, utilizer.
- Comments
  - Indication of research needs for disposal and/or utilization; suggestions for specific programs.

The information obtained through the questionnaires has been used to describe the industry in the preceding section and is discussed in appropriate following sections of this report.

Distribution. Questionnaires were distributed to 521 member-companies of the National Canners Association. These companies operate a total of 914 plants. Additionally, approximately 200 forms were distributed by the American Frozen Food Institute to its membership. Care was taken to avoid duplication of coverage since several companies maintain membership in both associations.

A total of 421 returns, each representing an individual plant, were received. The regional distribution of these responses is summarized in Table A4 in Appendix C. The representativeness of the coverage is discussed elsewhere.

Site Visits

Information Elicited. During the site visit phase of the program, details to supplement the questionnaire data were obtained. The information which was developed is outlined below.

Production

- Production Information
  - Raw products utilized: verification of processed products, tonnages, processes, yields; harvesting methods.
  - Plant changes: recent changes in production capabilities; equipment changes which affect residuals generation.
  - Product (process) flows.
- Residuals Information
  - Solid waste: sources and quantities, in-plant handling procedures, on-site accumulation and storage facilities, disposal methods.
  - Liquid waste: sources, management (handling and disposal).
- Costs
  - Capital, operating and maintenance costs for liquid and solid waste handling equipment and systems.

The above information is discussed in appropriate sections elsewhere in this report.

Coverage. During the 1970 processing season site visits were made to 229 plants. These processing plants were selected for site visits on the basis of geography, size of plant, and commodities handled, with consideration given to responses to the questionnaire. All major canned and frozen commodities were included. In many instances two or more products were being simultaneously processed at the time of the site visit; information was obtained for all products being handled at the time. Several plants which did not respond to the questionnaire were intentionally visited to encourage further responses, or at the least to obtain additional information to supplement the questionnaire data. The coverage achieved during the site visit phase of the program is summarized in Table A4 in Appendix C.

Data Precision

The precision of the data in the survey is discussed in several parts of the report as it pertains to the items in question. The number of plants surveyed by questionnaire and by visits, the tonnage of products represented in the data, and the distribution of sample plants among regions and processing methods appeared to be satisfactory. The distribution of sample plants among commodities was mostly good and among plant sizes was fair in representing numbers of plants and good in representing product and residuals tonnage. All sizes of plants were represented but the sample was biased toward larger plants. This bias could be taken into account in some instances and it had relatively little effect on data involving tons of raw product or of residuals.

Other sources of error, also mentioned in the appropriate sections of the report, were from incomplete, ambiguous or contradictory information. Some plants submitted no data on one or another of the questions. Incomplete information was used wherever possible; for example, the proportions of residuals disposed of by different methods by a given plant could be entered into averages even if the total residual tons were omitted. Some responses showed a misunderstanding of the question and had to be left out. The few contradictory responses were resolved by other evidence when possible.

In many instances, estimates rather than measured quantities were reported; for example, in the tonnage of residuals. Furthermore, even quantities reported as known weights included some error; for example, the added water in residuals weighed as wet solids would introduce error, as would assumptions that each truckload contained a constant tonnage. Some residuals data were reported in cubic yards and were converted to tons by an approximate factor, estimated from typical product densities.

Figures on the raw tons of some commodities used by the surveyed industry were not available directly and had to be estimated from statistics on the final product. Even when raw tonnages were published, they must have been based in part on estimate. Some of the data were for combined groups of states that did not coincide with the regions chosen for separate analysis in this survey; in this case, the appropriate distributions were estimated from pack figures.

Even though the overall representations of regions and of commodity tonnages in the survey were generally good, data on residuals and on operating seasons for a particular commodity in a particular region were sometimes insufficient to stand on their own. Information from an adjacent region was then transferred. As noted in the appropriate sections of the report, detailed data (for example, on each month or each disposal method in each region) are more likely to be in error than are data on totals.

The cost of handling wastes in the plant and especially liquid wastes costs were not in the original plan for the survey and were not emphasized in the data collection phases. The overall cost estimates are therefore very approximate.

Confidence limits were not calculated for most of the data. The reliability of much of the tonnage data is related to the percentages of U.S. total raw tons represented in the survey, listed elsewhere; the qualifications in the accompanying text should be noted. Many significant differences among regions, product classes, or processes in plant characteristics, residuals management methods, disposal site problems, and the like are pointed out. Significance in these cases is at roughly 95% confidence and is based on proportions of plants.

The surveyed industry encounters wide variability in some of the factors that influence waste production. For example, the size, maturity and other characteristics of raw products vary among plant varieties, fields, regions and seasons. Several product styles of the same commodity may be processed; for example, whole, halved, sliced, diced, juiced and concentrated styles. The equipment and methods used in preparing the raw product for preservation are fairly well standardized for some commodities but not for others; the process flow charts and descriptions give many examples of both.

Wide ranges among plants were found in some of the factors reported as averages; for example, in the quantities of residuals per ton of raw product and especially in costs.

Some reported columns of figures do not equal the given totals because the items were rounded independently after adding.

PRODUCTS AND PROCESSES

Introduction

The food canning and freezing industries process hundreds of commodities, utilizing numerous raw food materials in the production of these items. The processing operations vary widely from product to product. The large number of products and the variation of processes preclude the use of a single discussion to adequately describe common industrial practices. By the same token, to include discussions covering all variabilities is infeasible. Instead, the operations involved in the processing of major raw commodities within each category (vegetable, fruit, seafood and specialty) are described in the following.

Each discussion contains a description of:

1. Harvesting and Delivery: an outline of the procedures used to harvest the raw commodity and methods of delivery and storage; relationship of these to the quantity of residuals which are subsequently generated.
2. Product Preparation: an enumeration of the processing steps involved in the production of the major canned and frozen food items; identification of the operations which generate product residuals, with a description of the residual materials produced at each source.
3. Residuals Handling and Disposal: a description of the on-site procedures utilized to manage residuals and the means employed for the disposition of these materials.
4. Liquid Waste: a brief discussion identifying the sources of processing wastewater and the methods used for its management.

A process flow diagram is also provided for each of the discussed commodities. Most discussions are concluded with a summary of residuals management practices, as ascertained during the site visits which were conducted as part of the project. (In the case of products for which insufficient data were accumulated the summary is omitted). Each summary contains a tabulation of:

1. Waste Source(s): an enumeration of the unit operations which generate residuals.
2. In-plant Handling Methods: identification of the methods employed to convey residuals from the point of generation to the on-site storage or accumulation area. The methods are categorized as:

Dry Continuous: belt and screw conveyors, elevators, etc.

Wet Continuous: flumes and pumping systems.

Dry and Wet: combinations of the above.

Containers: buckets, barrels, bins, portable hoppers, etc.

Gutters: direct discharge of material into floor gutters.

3. On-site Storage: identification of the provisions for accumulation of residuals from each source. The common provisions are:

   Stockpile: accumulation of residuals in open piles.

   Containers: bins, portable hoppers, ''drop boxes'', etc.

   Elevated Hopper: large permanent structures.

   Truck: accumulation of residuals in a waste hauling vehicle.

   Other: all other methods, predominantly discharge and accumulation of residuals in settling basins.

4. By-product: enumeration of the principal uses for residuals. (Incidental feeding generally implies that the residuals are spread on land where animals are allowed to forage).

The discussion of commodities is generally limited to descriptions of those operations which are relatively unique to each specific product and of the residuals generated thereby. Aspects of residual generation (especially of non-food materials) and of liquid waste which are common to all canning and/or freezing plants are described separately.

General Processes

In the production of canned and frozen foods, residual materials are generated at numerous points. From the time of harvesting and delivery, through the processing operations, and to the final accumulation of finished product for shipment, each step creates residuals of varying characteristics. Those operations which are unique to specific commodities are described in the appropriate following discussions. However, some operations are common to all canning and/or freezing plants. These are described below.

Product Receiving.

Raw food materials are delivered to the processing plants in several types of containers. Most common among these are open-top trucks and trailers with bulk loads, wood or metal bins, and field boxes (also called lug or tote boxes). The method of shipment depends upon the nature of the raw product, the hauling distances, and the harvesting procedure.

Bulk shipments are generally unloaded directly into receiving hoppers or are dumped onto a paved area provided for this purpose. Bins and pallet-loads of boxes, however, are generally stacked on flatbed trucks. These containers are unloaded from the delivery vehicle with fork-lifts and are either stacked in the receiving area of the plant or taken directly to the process line.

During the unloading and dumping operations containers are inevitably damaged. Most plants provide a shop where broken bins, boxes, and pallets are repaired. Broken pieces and scrap lumber from the shop are generally accumulated in containers. Such combustible materials are periodically burned (where incineration or open burning is permissible) or disposed of at public landfill (either sanitary landfill or dump) sites.

Final Processing Operations.

Canning. After raw food materials are processed into the desired styles, the final product is placed into cans. The cans are then filled with brine or syrup, sealed, and sterilized in retorts. Depending upon the product and the equipment utilized, sterilization and subsequent cooling are conducted in batch lots or on a continuous basis. The cooled cans are removed from the can coolers and may either be stacked on pallets and stored for subsequent labeling and casing or conveyed directly to labeling and casing operations. Cased goods are stacked on pallets for storage and shipment to distributors or retail outlets.

During the filling and seaming operations, cans and can lids are occasionally damaged. Cans with minor dents are normally repaired and returned to the fillers. Unrepairable cans and damaged lids are accumulated in barrels or similar containers. If a metal salvaging facility is in convenient proximity to the plant, such metal wastes are delivered to that facility for recycling. Damaged cans filled with product are generally accumulated separately. If metal salvaging outlets are not available, the metal wastes and damaged cans filled with product are hauled to landfill disposal sites.

Labeling and casing operations result in the generation of paper and fiberboard wastes, as well as scrap wood from broken pallets. Fiberboard materials are frequently segregated for recycling. All other residuals from these operations are accumulated in containers. These combustible materials are periodically burned (where incineration is permissible) or disposed of at landfill sites.

Freezing. Depending upon the commodity and style, food products are packaged either before or after freezing. Products which are frozen prior to packaging are frequently stored in bulk containers and subsequently repackaged into retail-size containers. Product is placed into consumer-size containers, weighed to assure proper fill, closed, wrapped or labeled, and cased. Cased goods are stacked on pallets for storage and shipment to distributors and retail outlets.

During the packaging and casing operations, significant quantities of paper wastes may be generated. Damaged cartons and package wrappers or labels, as well as wood pieces from broken pallets, have no salvage value and, thus, require disposition. These materials are accumulated in containers and periodically burned (where incineration is permissible) or hauled to landfill sites. Product materials are normally recovered and returned to the fillers.

Liquid Waste.

Product Conveying. Several methods are commonly used to transport product from the receiving area into the processing plant and from one operation to another. These include the use of conveyor belts, screw conveyors, vibrating conveyors, bucket elevators, flumes, hydraulic pumping systems, and pneumatic conveying systems. The type of system used generally depends upon the nature of the product, although all of these systems are applicable for most products. The type of system which is utilized significantly influences the volume and the characteristics of the wastewater effluent.

The water in a hydraulic conveying system (flume and pumping system) is generally recirculated. Soluble solids are leached from the product being transported in water; particulates which are washed from the product tend to accumulate within the system. To maintain acceptable sanitary conditions within the hydraulic system, a continuous flow of fresh water is provided. Depending upon the nature of the product being transported, the resulting overflow, which is discharged into floor gutters, contains varying concentrations of dissolved and suspended solids. Additionally, recirculated fluming and pumping systems are completely drained and recharged with fresh water several times during each work shift. The drained water is discharged into the floor gutters.

When product is being transported on belts, product fragments and juices tend to adhere to the conveyors. These are washed from the belts by sprays which are generally provided for lubrication and sanitation purposes. The water which contains the fragments and juices is discharged into the gutters. Additionally, belt conveyors, as well as the other types, are thoroughly cleaned with a detergent solution and/or water several times during each work shift, as described below.

Plant Cleanup. Plant sanitation is of primary concern to all food processors. Since product fragments and juices are excellent media for the growth of various microorganisms, thorough equipment and general plant cleanups are frequently conducted during each work shift. Production is halted during each cleanup period, equipment is disassembled, and the entire plant is thoroughly cleaned with detergent and bacteriocidal solutions and thoroughly rinsed with copious applications of chlorinated water.

The cleanup wastewater, which contains all product residuals washed from the equipment and floors, is discharged into the gutter system. All wastewaters in the gutters are consolidated at a central point, screened to remove gross particulate matter, and are then discharged from the plant to the facilities provided for the general processing wastewater.

Can Coolers and Freezer Condensers. Significant quantities of fresh water are used to cool sterilized cans and to operate freezing equipment. The effluents from these operations are relatively uncontaminated and are generally but a few degrees warmer than the temperature of the input water. To minimize the intake water volume, many plants reuse this water in various processing operations. Plants which do not utilize these effluents, and plants which have an excess volume of water from these operations, generally keep this clean wastewater stream segregated from the general plant effluent. This flow is normally discharged into a municipal storm sewer or directly into a river or other receiving waters.

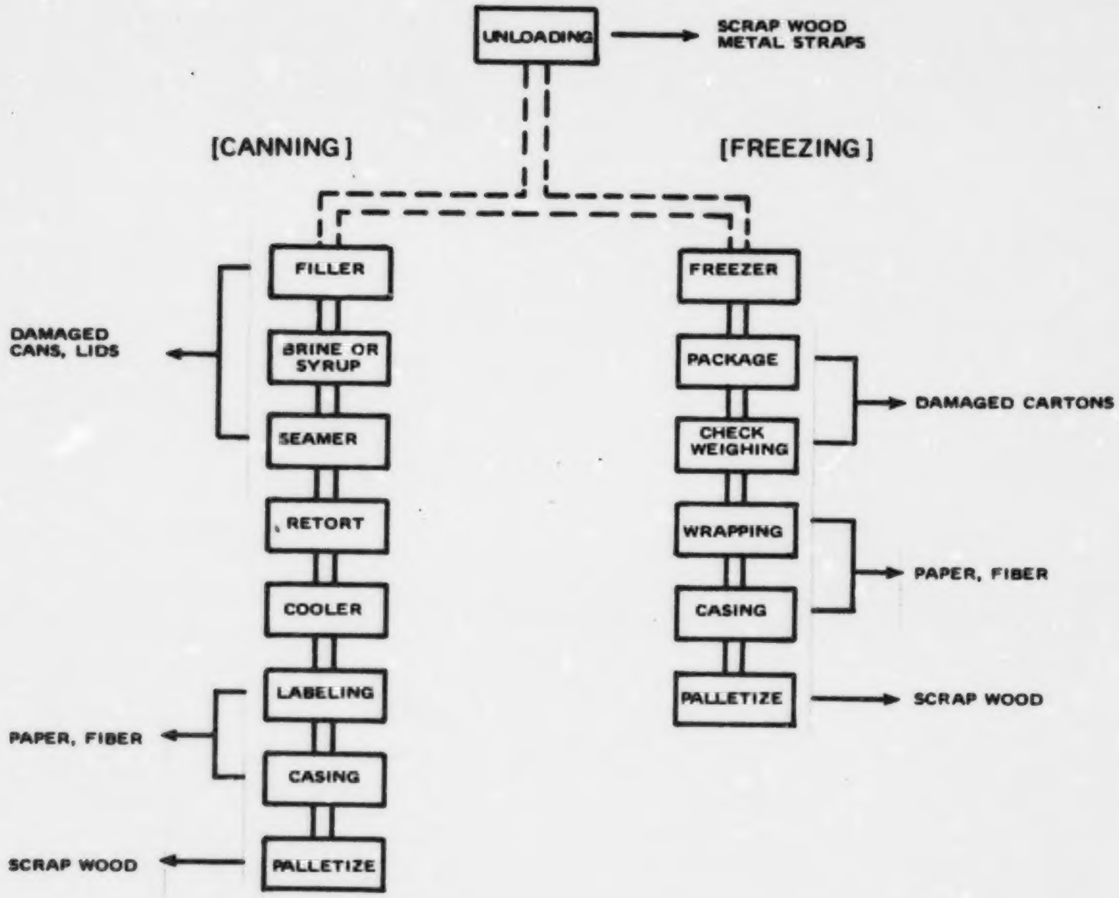

UNLOADING
SCRAP WOOD
METAL STRAPS
[CANNING]
[FREEZING]
FILLER
BRINE OR SYRUP
SEAMER
RETORT
COOLER
LABELING
CASING
PALLETIZE
DAMAGED CANS, LIDS
PAPER, FIBER
SCRAP WOOD
FREEZER
PACKAGE
CHECK WEIGHING
WRAPPING
CASING
PALLETIZE
DAMAGED CARTONS
PAPER, FIBER
SCRAP WOOD

Figure 1. General processes and sources of non-food residuals.

Asparagus

Harvesting and Delivery.

Asparagus for processing is currently hand-harvested. Asparagus spears which are 8 to 12 inches in length are cut just below the soil surface. These are placed in lug boxes, generally oriented with points up (although in a few situations the spears may be placed horizontally). The boxes are stacked on pallets and shipped to the processing plants immediately after harvest.

The pallets of boxes are unloaded from the trucks by fork-lifts. If the asparagus is not to be immediately processed, the lug boxes are stored in a cool area, generally with overhead sprays to keep the produce from wilting. In extremely warm climates, the boxes may be passed through a hydro-cooler of cascading chilled water prior to storage.

Product Preparation.

Unloading. Pallets of lug boxes are placed at the head of the process line. The asparagus is manually removed from the boxes and placed in small bunches between the cleats of a special conveyor belt. Spilled produce and broken spears accumulate on the floor and are discarded in a manner to be subsequently described.

Cutting. Rotary knives or ''saws'' are positioned adjacent and parallel to the cleated conveyor belt. As the asparagus spears are conveyed past the knives, the bottoms or butt-ends are severed from the asparagus, leaving a head spear 4- to 6-inches in length. Optionally, a second parallel knife may be provided to simultaneously cut an approximately one-inch section (''center cut'') just below the head spear. The trimmed butt-ends are discarded.

Washing. The head spears are conveyed to a washer. Where center cut sections are processed, separate washers are provided. Flood-type washers, consisting of an immersion tank with high-pressure overhead sprays, are most frequently used. Soil, loose bracts and broken tips are removed and discharged with the washer over-flow. The spears or center cut sections are removed from the washer by steel-mesh conveyors. A final rinse is generally provided.

Size Grading. The head spears are divided into several sizes by graders consisting of divergently-spaced rollers. Each size is collected on a separate conveyor. Bracts and broken tips are separated from the product flow and discarded.

Blanching. Asparagus is generally blanched by steam. The residence time of the asparagus in the blanchers is dictated by the size of the spears. Minimal quantities of soluble solids are leached from the asparagus during blanching; these solids are discharged from the unit with the steam condensate.

Cooling. Asparagus for freezing is cooled after blanching. Either flumes or overhead sprays are used for this purpose. Bracts and broken tips are discharged with the cooler effluent. Asparagus for canning is conveyed from the blanchers directly to the fillers.

Inspection. The asparagus spears, as well as center cut sections, are visually examined. Butt-ends, discolored product, broken and bent spears are manually removed. The butt-ends and discolored spears and sections are discarded; the broken and bent spears are diverted to cut asparagus lines.

Filling. Filling of cans is a manual operation. The spears are selected from a conveyor belt and placed with tips up into the containers. The cans are then filled with hot brine, the larger cans are passed through an exhaust box to remove entrapped air, and the cans are sealed for retorting. Excess spears which are not selected for canning at this point are diverted to the cut asparagus lines. Bracts and broken tips accumulate beneath the filling tables and are periodically swept or hosed into the gutters.

Packaging. Packaging of whole asparagus spears for freezing is a manual operation. Straight spears are selected from a conveyor belt and placed horizontally in cardboard cartons. The packages are check-weighed, wrapped and directed to freezers for preservation. Excess spears on the conveyor are diverted to the cut asparagus lines. Bracts and broken tips accumulate beneath packaging and check-weighing stations. These residuals are periodically swept or hosed into the gutters.

Cutting, and Filling or Packaging. Bent and broken asparagus spears removed from the whole spear inspection belts are combined with the excess spears not selected for whole spear packs. These are diverted to cutters which reduce the spears to segments 1/2- to 3/4-inch in length. In plants where center cut sections are produced, the cut spears are mixed with the center cuts. The product is visually examined; crushed and white fragments are removed and discarded. Circular filling tables are generally used to place cut asparagus into cans or cartons. The remaining operations are identical to the whole spear production.

Bracts and broken tips accumulate beneath cutters, conveyors and fillers. These residuals are swept or hosed into the gutters.

Residuals Handling and Disposal.

Some product residuals from asparagus processing are handled dry, but generally all residuals are handled in water.

Dry. In some processing plants, the butt-ends which are trimmed from the asparagus are collected on conveyor belts. The trimmed ends are transported from the processing area and discharged into portable hoppers, permanent hoppers, or directly into waste hauling trucks. However, these materials are more frequently handled in water, as described below.

Wet. Butt-ends which are trimmed from the asparagus spears are frequently collected on conveyor belts and discharged into flumes and/or gutters. Alternatively, the rotary knives are positioned over a flume or gutter enabling the trimmed ends to fall directly into the hydraulic system.

Broken tips and bracts are continuously removed from the product flow by blanchers, coolers and washers. These residuals are discharged directly into gutters with the wastewater effluent from the respective unit.

Product residuals which are removed from the inspection belts are either placed into flumes running parallel to the belts or into containers (buckets or pans) which are periodically emptied into floor gutters. Materials accumulate on the floor at various points throughout the plant, including the box unloading stations, size graders, fillers, packaging and check-weighing stations, and at all belt transfer points. These are periodically swept or hosed into the gutter system.

All residuals which are discharged into the gutter system are conveyed in wastewater overflows from various unit operations, as well as water utilized solely to continuously flush the system. These materials are collected at a central point and passed over a screen. The solids removed by the screen are collected in portable containers, permanent hoppers or directly in waste hauling trucks.

By-products. The residuals from most asparagus processing plants are utilized for animal feed. Where this utility is not feasible, these materials are disposed of by spread-and-cover operations or at public sanitary landfill sites.

Liquid Waste.

The largest volume of wastewater from asparagus processing is generated by the washers. Although the water within these units is recirculated, a high fresh water replacement rate is provided to convey residuals from the washers and to maintain acceptable sanitary conditions within the units.

In freezing plants, the coolers after the blanchers contribute large volumes of wastewater in the total plant effluent. When sprays are utilized, the water is discharged after a single use; water in flumes is recirculated, but a high replacement rate is provided.

Minor volumetric contributions are made by the condensate from steam blanchers and exhaust boxes, as well as equipment lubricating sprays and spilled brine. The blancher condensate is a major source of dissolved organic material.

All wastewater flows are discharged into the plant gutter system and ultimately consolidated at a central point. The composite flow is screened to remove gross particulates and the screened effluent is discharged into a municipal sewer system or to a company-operated treatment or disposal facility.

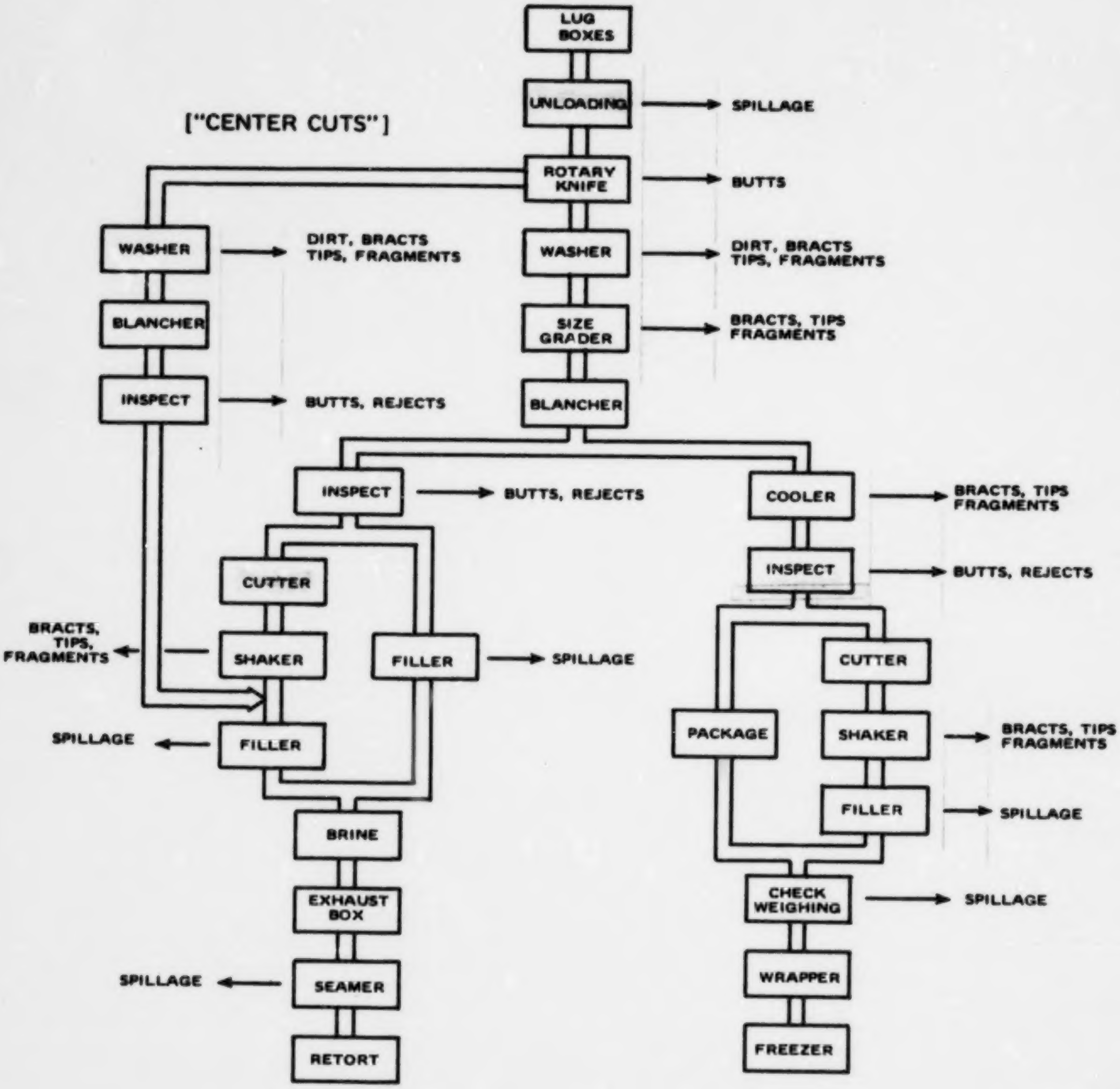

LUG BOXES
UNLOADING
SPILLAGE
["CENTER CUTS"]
ROTARY KNIFE
BUTTS
WASHER
DIRT, BRACTS TIPS, FRAGMENTS
WASHER
DIRT, BRACTS TIPS, FRAGMENTS
BLANCHER
SIZE GRADER
BRACTS, TIPS FRAGMENTS
INSPECT
BUTTS, REJECTS
BLANCHER
INSPECT
BUTTS, REJECTS
COOLER
BRACTS, TIPS FRAGMENTS
CUTTER
INSPECT
BUTTS, REJECTS
BRACTS, TIPS, FRAGMENTS
SHAKER
FILLER
SPILLAGE
CUTTER
PACKAGE
SHAKER
BRACTS, TIPS FRAGMENTS
SPILLAGE
FILLER
FILLER
SPILLAGE
BRINE
CHECK WEIGHING
SPILLAGE
EXHAUST BOX
SPILLAGE
SEAMER
WRAPPER
RETORT
FREEZER

Figure 2. ASPARAGUS -- process flow and sources of product residuals.

TABLE 14
MANAGEMENT OF ASPARAGUS RESIDUALS
A SUMMARY OF SITE-VISIT DATA

	Waste Source				
	Cutting (Butts)	Sorting (Center-Cuts)	Size Grading	Cutting (Spears)	Sorting (Spears)
Number of Plants	15	9	15	12	7
In-plant Handling Method					
Continuous					
Dry	3		2		
Wet	5		1	1	
Wet & Dry					
Containers					1
Gutters	7	9	11	11	7
On-site Storage Facility					
Pile					
Containers	1		1	1	
Elevated Hopper	10	8	10	9	4
Truck	4	1	4	1	2
Other*				1	1
By-product					
Feed					
Incidental Feed	8	6	8	6	4

Number of plants surveyed: 15

*Residuals discharged to storage pond.

Lima Beans

Harvesting and Delivery.

Lima beans of all varieties are currently being mechanically harvested. The cut vines are either hauled to nearby viner stations, or mobile field viners pick up cut vines from windrows and thresh the pods. The beans are air-cleaned, screened and collected in field bins or trucks. The vines and pods from the viner stations may be stacked for later use as animal feed, while those from the mobile field viners are discharged in the field and may be broken up by rotary cutters, along with other plant parts, and disced into the soil as mulch.

After removal from the pods, the beans are weighed, washed, and may be hydro-cooled before being discharged into bins or trucks for transport to the plant. Field and plant schedules must be closely coordinated to minimize the time between harvesting and processing to preserve quality.

Product Preparation.

Dumping, Cleaning. Unloading, particularly from bulk truck lots, is either hydraulic or pneumatic. The beans are caught on a belt and are conveyed through a system of water, air, reel and vibrator cleaners. The wastes, consisting of leaves, pods, pieces of vine and broken beans, are discharged to a belt and conveyed to a hopper.

Density Grading. Brine separation further serves to remove broken beans and pieces of vine material which are discharged to the gutter and flumed over a screen to a hopper. The brine also effects a quality grade separation.

Size Grading. The beans are usually size graded into 2 to 4 sizes and conveyed to the blancher.

Blanching. The beans are blanched in boiling water to soften and stabilize them, and then conveyed to a second brine separation where split beans are discharged to the gutter.

Sorting. From the density grader, the beans are discharged to a sorting belt where culls are manually removed to pans and dumped into the gutter.

Filling. If the beans are to be packaged in retail-size containers, they are conveyed to filling equipment; if they are to be stored in bulk containers they are sent directly to the belt freezer.

Residuals Handling and Disposal.

Lima beans should be fairly free from pieces of vines and pods when delivered to the plant, if the threshing operation in the field is satisfactory. At the plant the residuals are handled wet or dry and are discarded.

Dry. Leaves, pods, pieces of vines and broken beans are collected in a hopper or bins, dumped into a truck, hauled to a disposal site and spread on land.

Wet. Waste material from brine separations, sorting and spillage from conveying and filling operations are flushed to the gutter, flumed to a sump, pumped over a screen and the solid material collected in a hopper. The hopper is periodically emptied into a truck and the residuals hauled to a disposal site and spread on land.

By-products. Residuals from lima bean processing are frequently fed to animals. Where this utility is infeasible, these materials are disposed of on land.

Liquid Waste.

Food processing plants use large quantities of water to wash, blanch, and cool the product, lubricate and clean equipment, operate freezer condensing equipment, and to transport residual materials to on-site collection and storage facilities. For conservation of water and efficiency of operation, water is reused as far as practical, and finally used to transport residual materials.

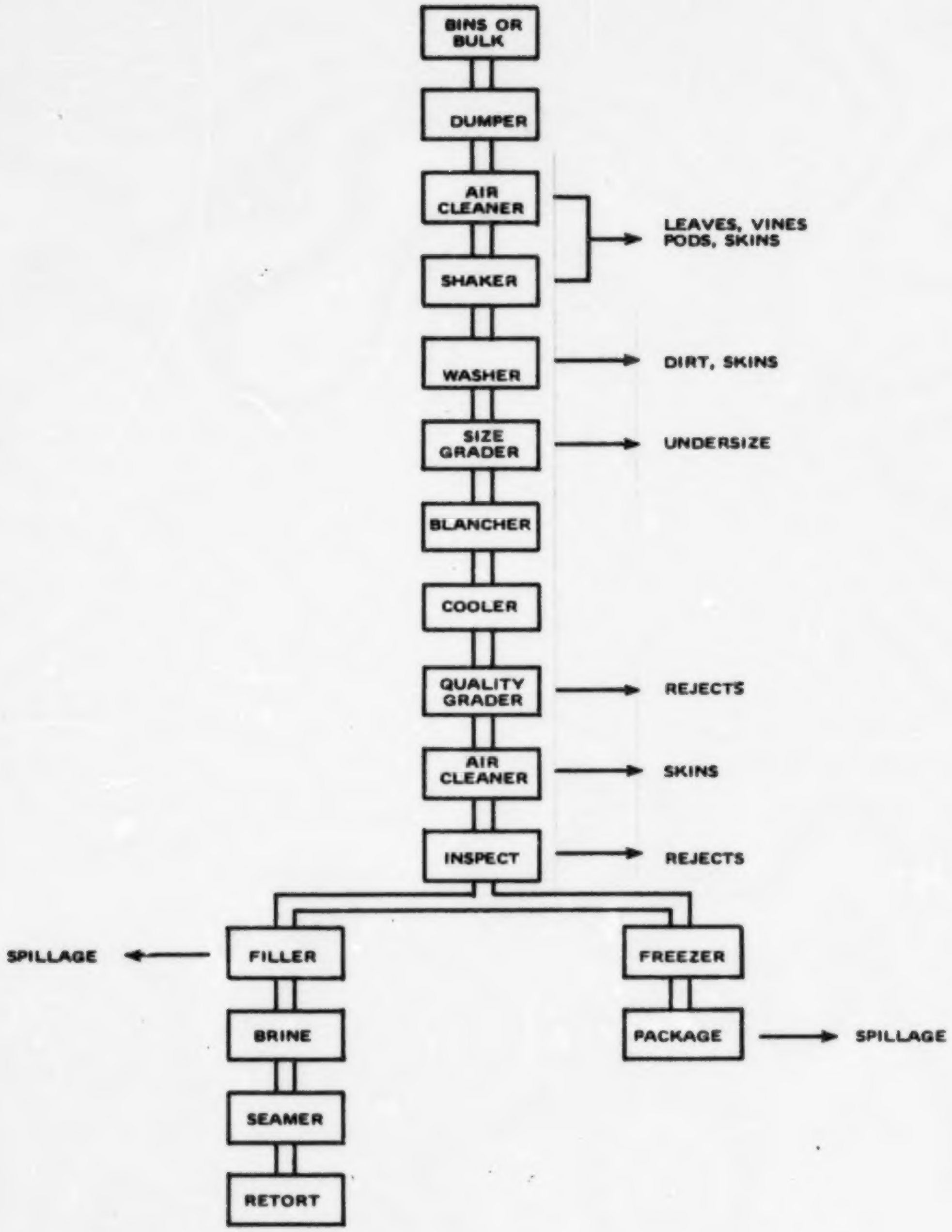
Major sources of liquid waste include transporting product in flumes and sumps, washing, blanching and cooling, and to operate freezer condensing equipment.

Major contributions to the organic load include product washing, transporting in flumes and sumps, and blanching and cooling.

Minor sources of liquid waste include continuous or intermittent washing of belts and equipment, usually by sprays, to assure a clean and efficient operation.

Liquid waste is thoroughly screened to remove solid material and then discharged to disposal systems.

LIMA BEANS



BINS OR BULK
DUMPER
AIR CLEANER
SHAKER
LEAVES, VINES PODS, SKINS
WASHER
DIRT, SKINS
SIZE GRADER
UNDERSIZE
BLANCHER
COOLER
QUALITY GRADER
REJECTS
AIR CLEANER
SKINS
INSPECT
REJECTS
SPILLAGE
FILLER
FREEZER
BRINE
PACKAGE
SPILLAGE
SEAMER
RETORT

Figure 3. LIMA BEANS -- process flow and sources of product residuals.

TABLE 15
MANAGEMENT OF LIMA BEAN RESIDUALS
A SUMMARY OF SITE-VISIT DATA

	Waste Source						
	Pneumatic Cleaning	Mechanical Cleaning	Washing	Froth Cleaning	Size Grading	Quality Grading	Sorting
Number of Plants	10	7	9	5	1	5	10
In-plant Handling							
Method							
Continuous							
Dry	4	3					
Wet							
Wet & Dry							
Containers		1					1
Gutters	6	3	9	5	1	5	10
On-site Storage							
Facility							
Pile							
Containers		1					
Elevated Hopper	4	1	5	3		4	7
Truck	6	5	4	2	1	1	3
Other							
By-product							
Feed	9	6	9	5	1	5	10
Incidental Feed							
Other							

Number of plants surveyed: 11

Snap Beans

Harvesting and Delivery.

Snap beans for processing are currently harvested both manually and by machine. Varietal differences dictate the growing and harvesting procedures.

Some varieties are ideally raised by providing a lattice-like support for the vines. The lattice-work is fabricated by stretching heavy string between poles which are relatively closely spaced throughout the field. The growing vines ''climb'' the lattice, thereby keeping maturing beans above the soil. These varieties are commonly referred to as ''pole beans'' and require hand-harvesting. Harvested pole beans are placed into bins which are stacked on flatbed trucks and trailers and delivered to the processing plant.

Some varieties of snap beans possess vines capable of supporting a greater weight by developing a bush-like plant. These varieties are suitable for mechanical harvesting and are referred to as ''bush beans''. Bush beans are stripped from the vines by machine, loaded directly into trucks or bins, and hauled immediately to the processing plant.

Product Preparation.

Since the snap bean varieties used for processing are now predominantly of the bush bean type, the following sections describe the processing steps to which bush beans are subjected. Where hand harvested pole beans are utilized, all steps prior to washing are by-passed; the remaining processing steps are identical.

Dumping. Snap beans delivered to the processing plant are generally processed within a short period of time. To assure an even flow of product into the plant, basic provisions for temporary storage are required. Beans delivered in bins are stacked in the receiving yard and emptied as needed onto a belt conveyor. Beans delivered in bulk are dumped into hoppers, or large metal bins, which are equipped with a wide belt in place of a floor. The beans are metered from these hoppers at a constant rate onto a belt conveyor.

Cleaning. Mechanically harvested snap beans are delivered with a significant quantity of dirt and extraneous plant material mixed with each load. Dirt clumps are separated by passing the product over a shaker sieve. Air cleaners (up-draft blowers) are utilized to remove extraneous plant material, such as vines and leaves, and a significant portion of loosely adhering dust. The beans are then passed through a ''cluster breaker'' to separate all beans which are still bunched. The product is passed through a second air cleaner to remove any remaining extraneous plant material.

Washing. Snap beans are washed by immersion in tanks, followed by rinse sprays. Agitation of the product in the tanks may be by high-pressure sprays supplied with recirculating water, or by revolving paddles. The product is removed from the wash tank by steel-mesh conveyors or by a spiral-lined cylinder. Rinse sprays are situated over the steel-mesh belts or within the cylinder to assure adequate cleaning of the product.

Snipping, Inspection. The product flow is directed to the bean snippers via feed hoppers. As the beans are passed through this apparatus, both ends of each bean are mechanically severed and dropped onto a conveyor belt or into containers, a flume or a gutter. The snipped beans are passed over an inspection belt from which unsnipped beans are withdrawn and returned to the snippers and defective beans are manually removed from the product flow. Shaker sieves are often employed between the snippers and inspection belt to remove snipped ends, as well as undersized beans and bean fragments.

Size Grading. For uniformity of final product, the snipped beans are divided into several size categories by a series of size graders. The smaller sizes are generally processed whole; the intermediate sizes are cut into segments; the larger sizes are cut into the shoestring or French-slice style.

Cutting, Grading. Snap beans are mechanically cut into segments of approximately one inch. For uniformity the cut segments are divided according to diameter into several sizes by a series of size graders. Undersized segments and fragments are separated from the product flow by these size graders. Such reject materials are discarded as product residuals.

Blanching, Cooling. Snap beans are generally blanched by immersion in hot water. Small beans for whole pack and cut beans are blanched prior to packaging; large beans for French style are blanched whole prior to slicing. The beans discharged from the blancher are cooled either in a flume or by sprays situated over a steel-mesh conveyor.

Slicing. Large snap beans are mechanically sliced into thin diagonal strips and are referred to as the French style. The beans so sliced are previously blanched and cooled for frozen product. Cooling is optional for product to be canned. Minor quantities of waste, consisting solely of spillage, are generated at this operation.

Filling (canning). The larger whole beans are manually placed into cans. All other styles of beans may also be manually placed into cans but are more frequently filled mechanically. The cans are then filled with hot brine, optionally exhausted, and sealed.

Packaging (freezing). Whole and French styles are generally manually placed into cartons prior to freezing. These cartons are check-weighed, wrapped and placed onto trays. Minor quantities of residuals result from spillage at the filling and weighing operations. Cut beans are frozen before packaging.

Residuals Handling and Disposal.

Product residuals from snap bean processing operations are handled either in water or dry.

Dry. Residual materials separated from the product flow at the cleaning operations are most frequently handled in a dry state. These materials may be collected directly in bins, portable hoppers or similar containers which are periodically dumped into trucks, or may be conveyed by belt or screw conveyers to storage hoppers or directly into a waste hauling truck. Residuals generated at this point are disposed of.

Residuals generated within the processing plant are also often handled dry and are removed from the processing areas in containers or by belt or screw conveyors. Materials so handled include residuals from the snippers, inspection belt, and both whole and cut bean size graders. These materials are accumulated in the yard in containers (bins or portable hoppers) or temporarily stored in permanent hoppers.

Wet. Debris removed from the product flow during the washing operation is continuously discharged into the plant floor gutters. Additionally, spillages which occur at various points in the processing area are periodically flushed into the gutter system. These materials are conveyed by water to a central point where the residuals are removed from the liquid by screens. The screened solids are accumulated in portable containers, permanent hoppers or loaded directly in a waste hauling truck.

In many plants the residual materials from snippers, inspection, and size graders are conveyed from unit operations by flumes which are discharged into the gutter system. Only infrequently are the residuals from the cleaning operation so handled. All residuals discharged into the gutters are handled as described above.

By-product. Product residuals from snap beans are generally utilized as stock feed. Local farmers haul these materials from the plant for this purpose. Where such utilization is not practicable, residual materials must be disposed of, most frequently by land disposal methods.

Liquid Waste.

The major sources of wastewater from snap bean operations are the washer, blancher and cooler. Although water used in these operations is recirculated within each respective unit, a high fresh-water replacement rate is provided to assure the maintenance of water of suitable quality. The overflows from these units are used to convey residuals which are discharged into the gutters from the processing areas.

All wastewater flows are collected in floor gutters and are ultimately consolidated. The composite effluent is passed over screens to remove gross particulate matter and is discharged into a municipal sewer system or a company-operated treatment or disposal system.

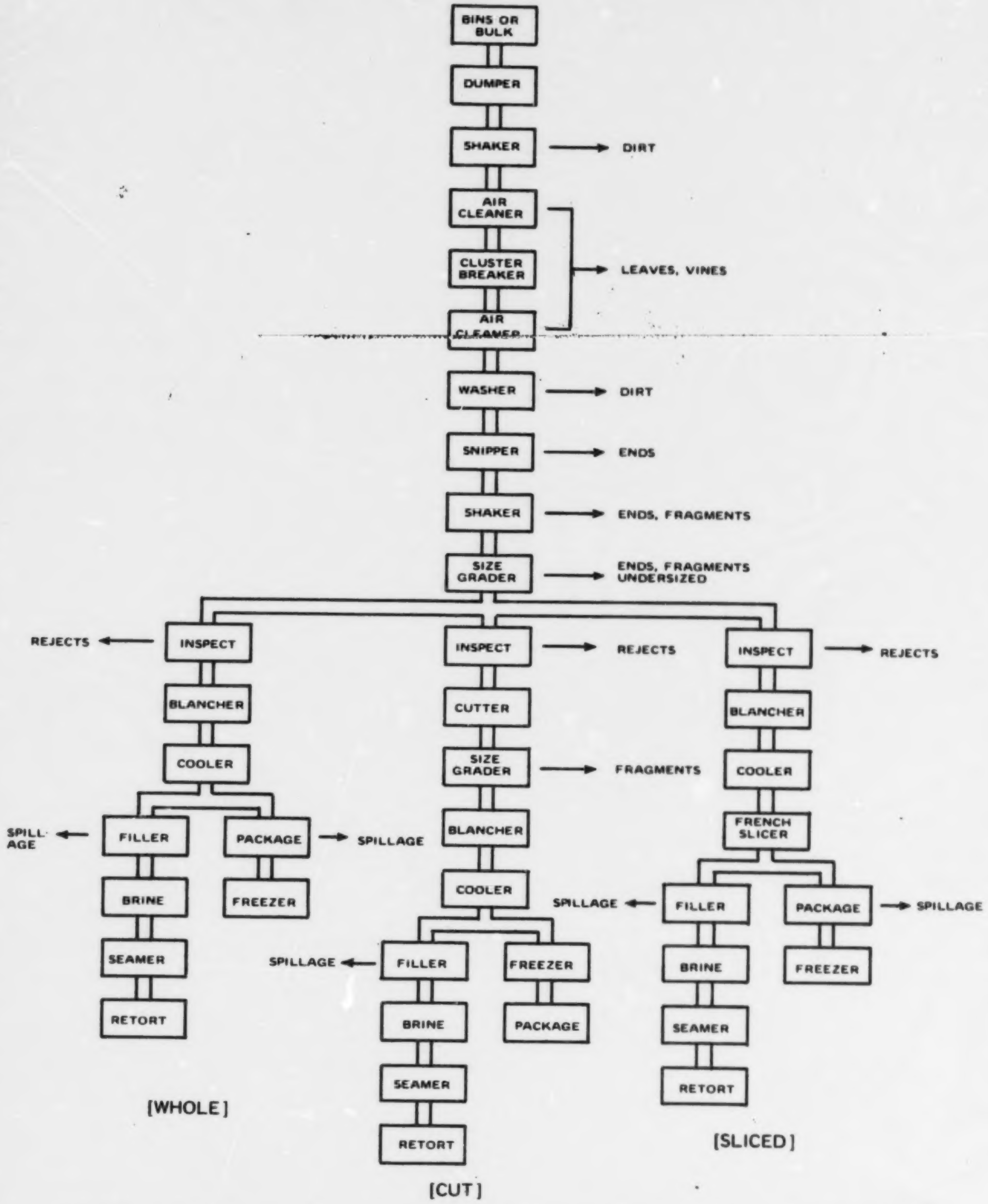

BINS OR BULK
DUMPER
SHAKER
DIRT
AIR CLEANER
CLUSTER BREAKER
LEAVES, VINES
AIR CLEANER
WASHER
DIRT
SNIPPER
ENDS
SHAKER
ENDS, FRAGMENTS
SIZE GRADER
ENDS, FRAGMENTS UNDERSIZED
REJECTS
INSPECT
BLANCHER
COOLER
SPILLAGE
FILLER
PACKAGE
SPILLAGE
BRINE
FREEZER
SEAMER
RETORT
[WHOLE]
INSPECT
REJECTS
CUTTER
SIZE GRADER
FRAGMENTS
BLANCHER
COOLER
SPILLAGE
FILLER
FREEZER
BRINE
PACKAGE
SEAMER
RETORT
[CUT]
INSPECT
REJECTS
BLANCHER
COOLER
FRENCH SLICER
SPILLAGE
FILLER
PACKAGE
SPILLAGE
BRINE
FREEZER
SEAMER
RETORT
[SLICED]

Figure 4. SNAP BEAN -- process flow and sources of product residuals.

TABLE 16
MANAGEMENT OF SNAP BEAN RESIDUALS
A SUMMARY OF SITE-VISIT DATA

	Waste Source					
	Trash Removal	Pneumatic Cleaning	Mechanical Cleaning	Size Grading	Snipping	Sorting
Number of Plants	19	19	13	12	22	22
In-plant Handling						
Method						
Continuous						
Dry	3	6	4	3	5	4
Wet	1				1	
Wet & Dry	1				1	
Containers	10	9	5	5	5	10
Gutters	4	4	4	4	10	11
On-site Storage						
Facility						
Pile		1				
Containers	2	3	1	2	1	1
Elevated Hopper	2	4	3	3	10	8
Truck	15	11	9	7	12	13
Other						
By-product						
Feed	1	2	2	2	3	3
Incidental Feed	3	6	4	6	10	10

Number of plants surveyed: 22

Beets

Harvesting and Delivery.

Beets for processing are almost exclusively machine-harvested. The leaves are removed (topped) and left in the fields; the beets are loaded directly into open-top trucks and hauled immediately to the processing plant.

Delivered beets are dumped into receiving hoppers at the plant. From the hoppers, the beets may be conveyed directly into the processing plant, or may be diverted to storage bins, frequently after washing, for later processing. Conveyance to and from the storage area is by gravity and/or belt systems. There is no appreciable generation of residual materials associated with these operations.

Product Preparation.

Washing. Since beets are a root vegetable, a significant quantity of soil adheres to the outer surface of each beet. Additionally, clumps of dirt are often included in each load. Dirt clumps and adhering soil are removed from the product by washers. The most common type of washer utilized for this purpose is a rotating cylinder equipped with spray nozzles. The cylinder may be constructed of perforated steel or fashioned with steel bars. Mud and extraneous debris are conveyed from the unit with the discharge effluent.

Size Grading. To achieve maximum peeling efficiency, the beets are divided into several size categories according to diameter. This is accomplished with a rotating cylinder perforated by increasingly larger openings. Some residuals, mainly leaves, are discarded during the size grading operation.

Peeling. The skins on the beets are softened by subjecting the vegetables to a steam atmosphere or by applying a hot caustic solution, often preceded by blanching. The residence time required to adequately soften the surface tissue is determined by the size and maturity of the beets.

Following steam or caustic application, the beets are subjected to high-pressure sprays, generally in a reel-type washer. The force of the water stream, coupled with the friction induced by the tumbling action, result in the removal of the softened surface tissues. The peel material, as well as some soluble solids which are leached from the product, are carried from the process in the wastewater flow.

The peeling process is completed by quickly passing the beets over carborundum-coated rollers, or abrasive peelers. This ''polishing'' process physically removes all remaining peel material, as well as some of the beet tissue previously exposed. Material removed during this process is discharged as fine suspended solids with the wastewater resulting from sprays which are provided for final rinsing.

Trimming and Inspection. Whole peeled beets are placed on a conveyor belt and visually examined. Blemishes are manually trimmed; product unacceptable for various reasons is manually removed from the product flow.

Size Grading. To assure better uniformity of final product, the peeled whole beets are graded into three or more size categories. The small sizes are canned as whole beets; the intermediate sizes are sliced; the large sizes are diced or cut into strips. The size graders reject unusable under-sized beets and beet fragments.

Inspection. Peeled beets for whole and sliced styles are visually examined. Small beets which are incompletely peeled are rerouted to abrasive re-peelers and are size graded a second time. Materials removed by the re-peelers are discharged with the rinse water.

Whole beets which have been excessively trimmed and are thereby unacceptable for whole or sliced styles are diverted to the dicers or cutters. Beets which are unacceptable for various reasons are manually removed from the product flow.

Slicing, Size Grading and Final Inspection. The intermediate sized beets are sliced to form disc-shaped product of approximately 1/4 - inch thickness. The slices are separated into several size grades; the very small slices, which include the top and bottom slices, are discarded. The slices are visually examined and irregular or otherwise unacceptable pieces are manually removed from the product flow.

Cutting and Dicing. The large beets are passed through cutting or dicing machines. The cutters produce strips for Julienne, or shoestring, style beets; the dicers produce cubes of pre-selected dimensions. Small fragments produced by the dicers may be removed by shaker sieves; fragments from cutters are generally not removed. Minimal amounts of spillage occur at both operations.

Filling. Beets are most frequently placed manually into cans, usually with the aid of circular or trough filling tables. Spillages are common around filling tables.

The cans are filled with hot water or hot brine, exhausted to remove entrapped air, and sealed for retorting.

Residuals Handling and Disposal.

Product residuals from beet processing operations are handled both dry and wet.

Dry. Residual materials removed by size graders, at trimming belts and during inspection are frequently handled dry. Manually removed residuals, such as defective vegetables and trimmings, are placed into pans or barrels which are periodically emptied into portable hoppers or similar containers. Alternatively, these materials may be placed on conveyor belts which transport the residuals to portable hoppers. Mechanically separated residuals are generally handled by conveyor belts.

Residual materials accumulated in portable hoppers or bins are loaded directly into waste hauling trucks. In a few cases, materials handled by conveyor belts are discharged directly into these same trucks.

Wet. A few of the beet processing operations generate residuals as an aqueous slurry. These include mud from the washers, and peel from the steam or caustic applicator, spray washer, abrasive peeler and re-peeler. These materials are discharged into the gutter system and transported by wastewater originating from each respective unit. Additionally, spillages which occur at various points throughout the plant are periodically hosed into the gutters and conveyed from the processing areas.

In many plants residual materials which may be handled dry, as previously described, are discharged into flumes or directly into gutters and hydraulically conveyed from the processing areas. Residuals which can be removed from water by screens are accumulated in portable containers or permanent hoppers for eventual loading into waste hauling trucks.

By-products. A minimal quantity of beet residuals is utilized as livestock feed. Most beet processing plants are required to dispose of residual materials, generally employing land disposal methods.

Liquid Waste.

The two major sources of wastewater are the washer and the various components of the peeling operation. The wash water is frequently handled and treated separately; the peeler wastewater is combined with the other waste streams.

The wash water contains a significant dirt load but very little organic contaminants. This waste stream is generally discharged into a clarifier or settling basin where the bulk of the soil is removed. The effluent from the clarifier or settling basin is then discharged into a municipal system or a company-operated treatment system.

The peeler effluent contains high concentrations of dissolved organic material and suspended solids. To this stream are added more or less minor volumetric contributions from belt and equipment lubricating sprays, spilled brine, exhaust box condensate, and cleanup water. These flows are collected in floor gutters and are ultimately consolidated. The composite flow is passed over screens to remove gross particulates and is discharged into a municipal sewer system or a company-operated treatment or disposal system. Unique treatment problems are associated with beet wastewater due to the difficulty in removing the intense red beet color pigment.

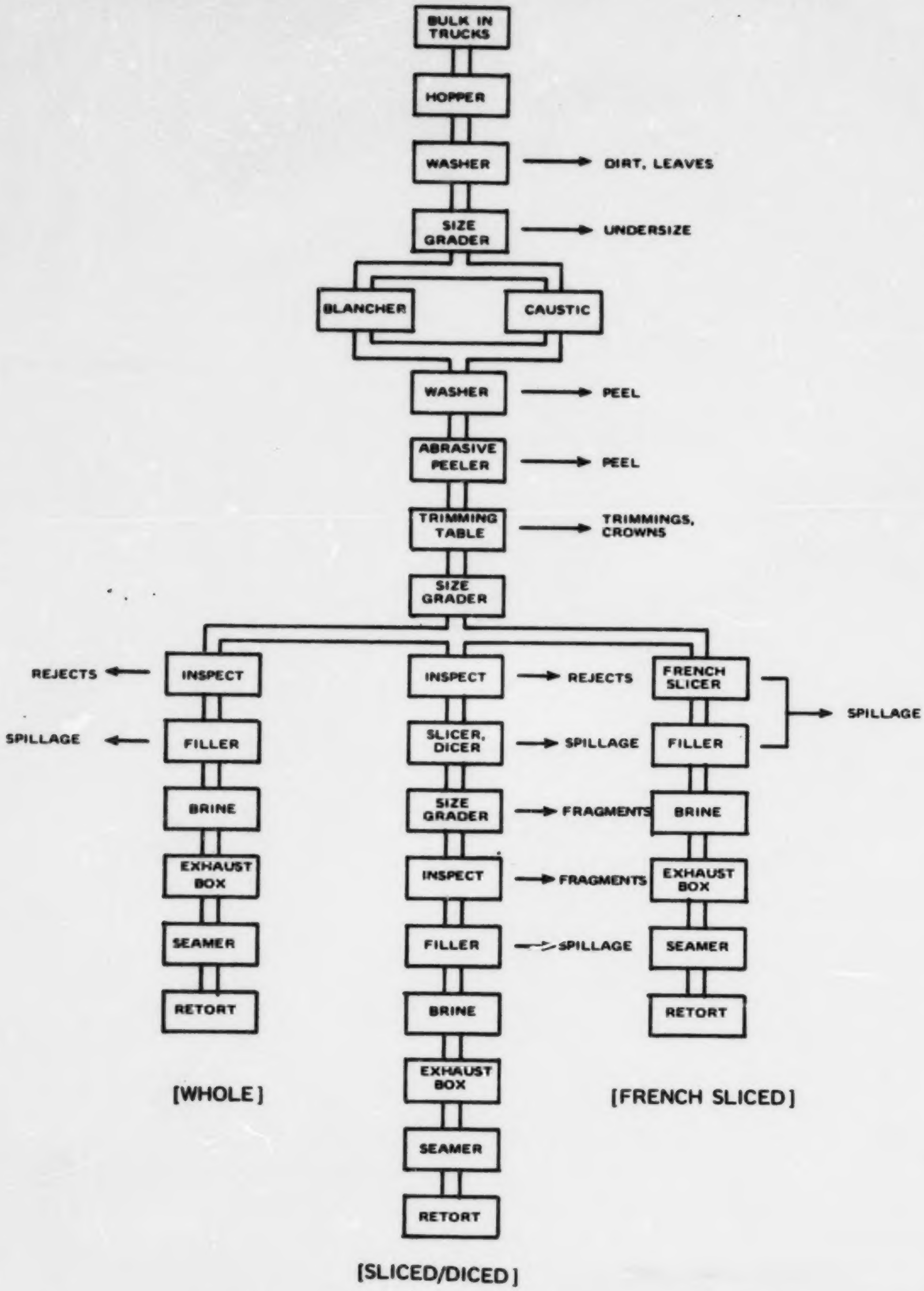

BULK IN TRUCKS
HOPPER
WASHER
DIRT, LEAVES
SIZE GRADER
UNDERSIZE
BLANCHER
CAUSTIC
WASHER
PEEL
ABRASIVE PEELER
PEEL
TRIMMING TABLE
TRIMMINGS, CROWNS
SIZE GRADER
REJECTS
INSPECT
SPILLAGE
FILLER
BRINE
EXHAUST BOX
SEAMER
RETORT
[WHOLE]
INSPECT
REJECTS
SLICER, DICER
SPILLAGE
SIZE GRADER
FRAGMENTS
INSPECT
FRAGMENTS
FILLER
SPILLAGE
BRINE
EXHAUST BOX
SEAMER
RETORT
[SLICED/DICED]
FRENCH SLICER
FILLER
SPILLAGE
BRINE
EXHAUST BOX
SEAMER
RETORT
[FRENCH SLICED]

Figure 5. BEETS -- process flow and sources of product residuals.

75

TABLE 17
MANAGEMENT OF BEET RESIDUALS
A SUMMARY OF SITE-VISIT DATA

	Waste Source						
	Cleaning	Washing	Grading	Peeling Rinsing	Trimming	Sorting	Slicing Dicing
Number of Plants	6	5	1	8	8	8	7
In-plant Handling							
Method							
Continuous							
Dry	4		1	1	1	1	1
Wet						1	1
Wet & Dry							
Containers	1				3	2	1
Gutters		4		7	4	4	4
On-site Storage							
Facility							
Pile	1						
Containers							
Elevated Hopper				2	2	2	3
Truck	5	2	1	6	6	6	4
Other		3*					
By-product							
Feed	1				2	2	1
Incidental Feed							
Other							

Number of plants surveyed: 8

*Mud in washwater discharged to settling basin.

Cabbage

(Sauerkraut)

Harvesting and Delivery.

About half of the cabbage harvested for sauerkraut production is mechanically picked. The remainder is hand-harvested. In either case, the jackets of the plant are removed and left in the field. The cabbage heads are loaded directly into open-top trucks or trailers in which the produce is hauled to the processing plant.

Product Preparation.

Dumping. The cabbage is generally dumped into a receiving hopper which has a metering belt in place of a floor. At a few plants, the delivered produce is dumped onto a pavement from which the cabbage heads are manually lifted onto conveyor belts leading into the processing plant. Outer leaves which are rubbed off from the cabbage heads accumulate in significant quantity at this point.

Washing. Washing is an optional operation. Processors who employ this operation utilize over-head spray arrangements.

Trimming and Coring. The stalk-end of each head is manually trimmed and the coarse outer leaves are removed and discarded. The core, or fibrous inner tissue, is then semiautomatically removed. Each head is manually placed on a machine equipped with one to four tubular borers which operate in a fashion similar to machine-shop drill presses. The core material removed by this process is discarded.

Shredding. The trimmed and cored heads are passed through a mechanical shredder which reduces the cabbage into thin strips. Only a minimal quantity of residual material, in the form of small fragments, is generated at this operation. The shredded cabbage is salted and collected in plastic-lined bins or carts and conveyed to wooden storage tanks which are normally lined with plastic sheeting. Additional salt is added to the tank with each load.

Fermentation. Upon filling, each tank is covered with plastic sheeting and the cabbage is allowed to undergo fermentation. or curing, for a period of approximately six weeks. During the filling period and early storage, much of the liquid contained in the cabbage is released, thereby dissolving the salt and forming the brine solution in which the fermentation organisms are supported. Mineral oil is often spread over the surface of the liquid to seal the brine solution from air-borne contaminants. No residual material is associated with this process.

Removal of Sauerkraut from Tanks. After completion of the fermentation process, the cabbage, now called sauerkraut, is removed from the tanks for further processing. The oil and brine are first separately pumped to storage tanks. The oil is held for reuse; the brine may be utilized as the canning brine or canned as sauerkraut juice. The sauerkraut is removed from the tanks either manually into bins or carts, or with the assistance of mechanical or pneumatic conveyors. A minimal loss is generally incurred during this operation due to product spillage.

Preheating. Sauerkraut is normally preheated to pasteurization temperatures prior to canning. Preheating tanks containing liquid (brine or water) heated by steam injection are generally used for this purpose. Spillages at this operation are not uncommon.

Filling. Sauerkraut is placed into cans either mechanically or manually. Hot brine is then added to fill the void spaces and the cans are sealed.

Although not a common procedure, sauerkraut may be placed into cans without preheating. For such cold-fill procedures, hot brine is added and the cans are exhausted in a steam atmosphere to heat the contents to pasteurization temperature prior to sealing. Sealed cans of sauerkraut do not require retorting and are thus simply cooled, generally by sprays.

Residuals Handling and Disposal.

Product residuals from sauerkraut operations are handled by both hydraulic and mechanical or other dry systems.

Dry. Cabbage residuals generated at unit operations preceding the fermentation tanks are normally handled dry. Leaves and cores from the trimming and coring operations are transported from the processing area by belt or drag conveyors. These materials are collected in portable containers, permanent hoppers or directly in the hauling truck. Spillages in the dumping area and around the shredders are generally swept off the floor and placed into containers which are emptied onto the residuals conveyor or directly into the trucks.

Wet. Sauerkraut residuals generated at unit operations subsequent to the fermentation tanks are normally carried from the processing plant in the gutter system. This consists almost exclusively of sauerkraut spilled onto the floor at the storage tanks, pre-heater, and filler. Materials carried in the gutter system are removed from the plant effluent by screening and are collected in portable containers, permanent hoppers or loaded directly into the hauling truck.

By-product. There is no current utility for either the cabbage or screened sauerkraut residuals. Although a small quantity is incidentally fed to animals, these materials are generally disposed of by landfill and/or spread-and-cover techniques.

Liquid Waste.

The major source of wastewater from sauerkraut canning plants is the preheating tank. This unit is operated with a high overflow rate. The effluent stream contains a significant quantity of salt. Where washers are employed, this operation is also a major source of wastewater. However, the waste streams from washers contain very low concentrations of pollutants.

Minor volumetric contributions are made by juice spillages from the storage tanks, spilled brine and condensate from exhaust boxes where these are utilized.

All of the wastewater flows described above are collected in floor gutters and are ultimately consolidated. The composite flow is passed over screens to remove gross particulate matter and is discharged into a municipal sewer system or a company-operated treatment or disposal system.

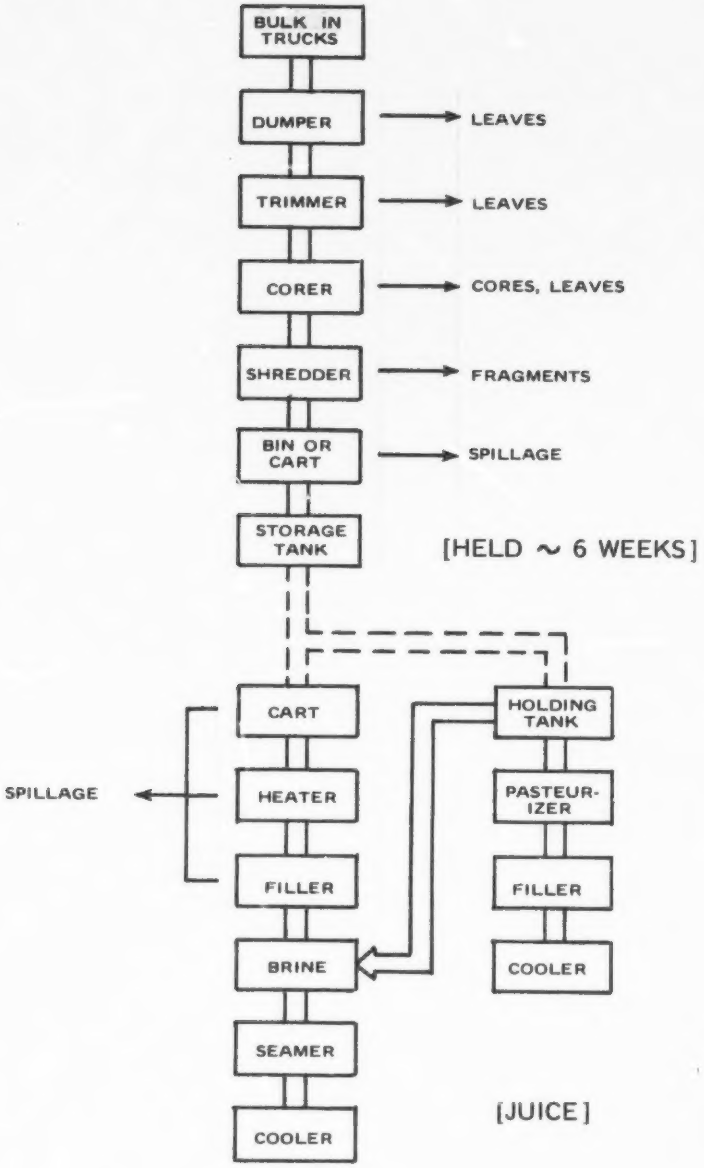

BULK IN TRUCKS
DUMPER
LEAVES
TRIMMER
LEAVES
CORER
CORES, LEAVES
SHREDDER
FRAGMENTS
BIN OR CART
SPILLAGE
STORAGE TANK
[HELD ~ 6 WEEKS]
CART
HOLDING TANK
SPILLAGE
HEATER
PASTEUR-IZER
FILLER
FILLER
BRINE
COOLER
SEAMER
[JUICE]
COOLER

Figure 6. CABBAGE (sauerkraut) -- process flow and sources of product residuals.

TABLE 18
MANAGEMENT OF CABBAGE RESIDUALS
A SUMMARY OF SITE-VISIT DATA

	Waste Source			
	Dumping	Trimming	Coring	Shredding
Number of Plants	6	6	6	6
In-plant Handling Method				
Continuous				
Dry	5	6	6	5
Wet				
Wet & Dry				
Containers	1			1
Gutters				
On-site Storage Facility				
Pile				
Containers	1			
Elevated Hopper	2	3	3	3
Truck	3	3	3	3
Other				
By-product				
Feed				
Incidental Feed	2	2	2	2
Other				

Number of plants surveyed: 6

Carrots

Harvesting and Delivery.

Carrots for processing are grown in sandy loam soil, as far as practicable, to minimize wet weather harvesting problems, and to reduce the amount of soil adhering to the carrots after harvest. As the mechanical harvester travels through the fields, it pulls the carrots, removes the leafy tops, and conveys them by mesh flight elevator to a truck traveling along side. The mesh flight elevator is usually agitated to remove soil loosely adhering to the carrots.

In some field operations the truck load is dumped into a hopper and the carrots are passed over a belt where sorters remove culls and small carrots. The sorted carrots are filled into bins or bulk truck for delivery to the processing plant.

Product Preparation.

Dumping, Washing. The carrots are dumped into a hopper and fed into a long, reel-type dry washer with a large mesh screen. The carrots tumble through the turning reel and the loose soil is removed and caught in bins below. The soil is dumped into a truck for disposal. The carrots are discharged into a second reel equipped with high pressure sprays where they are thoroughly washed and conveyed to the size grader. The mud and wash water are collected in a settling tank; the mud settles to the bottom and is periodically removed to containers for disposal.

Size Grading. If the carrots are to be sliced they are separated into several sizes and returned to bins for further processing. The undersize is held in bins for disposal. If only the diced style is to be packed, only the undersize carrots are separated at the grader.

Sorting. The sized carrots are dumped to a belt where split and woody carrots are sorted out to the gutter and flumed to a hopper for disposal.

Peeling, Washing. From the sorting belt the carrots are conveyed to a steam or lye peeler, where they are peeled and rinsed. The peel and spent lye solution (if used) is discharged to the gutter with the rinse water for disposal. Peeling is essential, otherwise the finished product will have an earthy flavor.

Topping, Trimming. The tops, or crowns, are cut mechanically or manually and the carrots are trimmed to remove blemishes. Tops and trim are discharged to the gutter for disposal.

Slicing, Dicing. After topping and trimming, the carrots are sent on separate lines to the dicer or slicer. Small pieces in the cut units are removed by reels with rods, or shakers with perforated screens. The pieces are collected in bins for disposal.

Sorting. The diced and sliced carrots are sorted on separate belts and the culls discharged to the gutter for disposal.

Blanching, Cooling. If the carrots are to be canned and sterilized, this step is omitted and they are conveyed (slices only) to the size grader; or directly (dices only) to the can filler.

For freezing, the cut units are water blanched, drained and water cooled, either in a flume or closed pump and pipe system of considerable length. After cooling, the slices or dices are dewatered on a perforated shaker. Small pieces are discharged to the gutter for disposal. The dices are sent to the packaging unit, and the slices are sent to the size grader.

Size Grading (Slices). Since carrots have a tapered shape, the slices vary in size and must be size graded prior to canning or packaging.

Filling. Dices and slices for canning are sent on separate lines to fillers and to further processing. If they are to be frozen, they are either filled into consumer-size packages and sent to further processing, or sent to the belt freezer for bulk handling.

Residuals Handling and Disposal.

The residuals from carrot processing are handled either wet or dry and are discarded.

Dry. Dry field soil from the initial cleaning operation is dumped into a truck and hauled to land fill. The undersize from whole carrot grading and the small pieces from dicers and slices are hauled by truck and spread on land for animal feed.

Wet. Mud from wash water in the settling tank is dumped into a truck and hauled to land fill. The tops and trims, small pieces from slicing and dicing, culls from sorting belts, pieces from shakers after product cooling, and incidental residual material are sorted or flushed to the gutter, flumed to a sump, pumped over a screen and the solid material collected in a hopper. Periodically the hopper is emptied into a truck and the residuals spread on land for animal feed.

By-products. Product residuals from carrot processing are spread on land for animal feed. Materials which are not consumed are disced into the soil.

Liquid Waste.

Food processing plants use large quantities of water to blanch and cool the products, lubricate and clean equipment, operate sterilizing or freezing equipment, and to transport residual materials to on-site collection and storage facilities. For conservation of water and efficiency of operation, water is reused as far as practicable, and finally used to transport residual materials.

Major sources of liquid waste include transporting product in flumes and pumps, washing, blanching and cooling, and to operate either freezer condensing equipment or sterilizing and cooling equipment.

Major contributors to the organic load include product washing, transporting in flumes and pumps, lye or steam peeling and washing, blanching and cooling, and transporting residuals.

Minor sources of liquid waste include continuous or intermittent washing of belts and equipment, usually by sprays, to assure a clean and efficient operation.

Liquid waste is thoroughly screened to remove solid material and is then discharged to disposal systems.

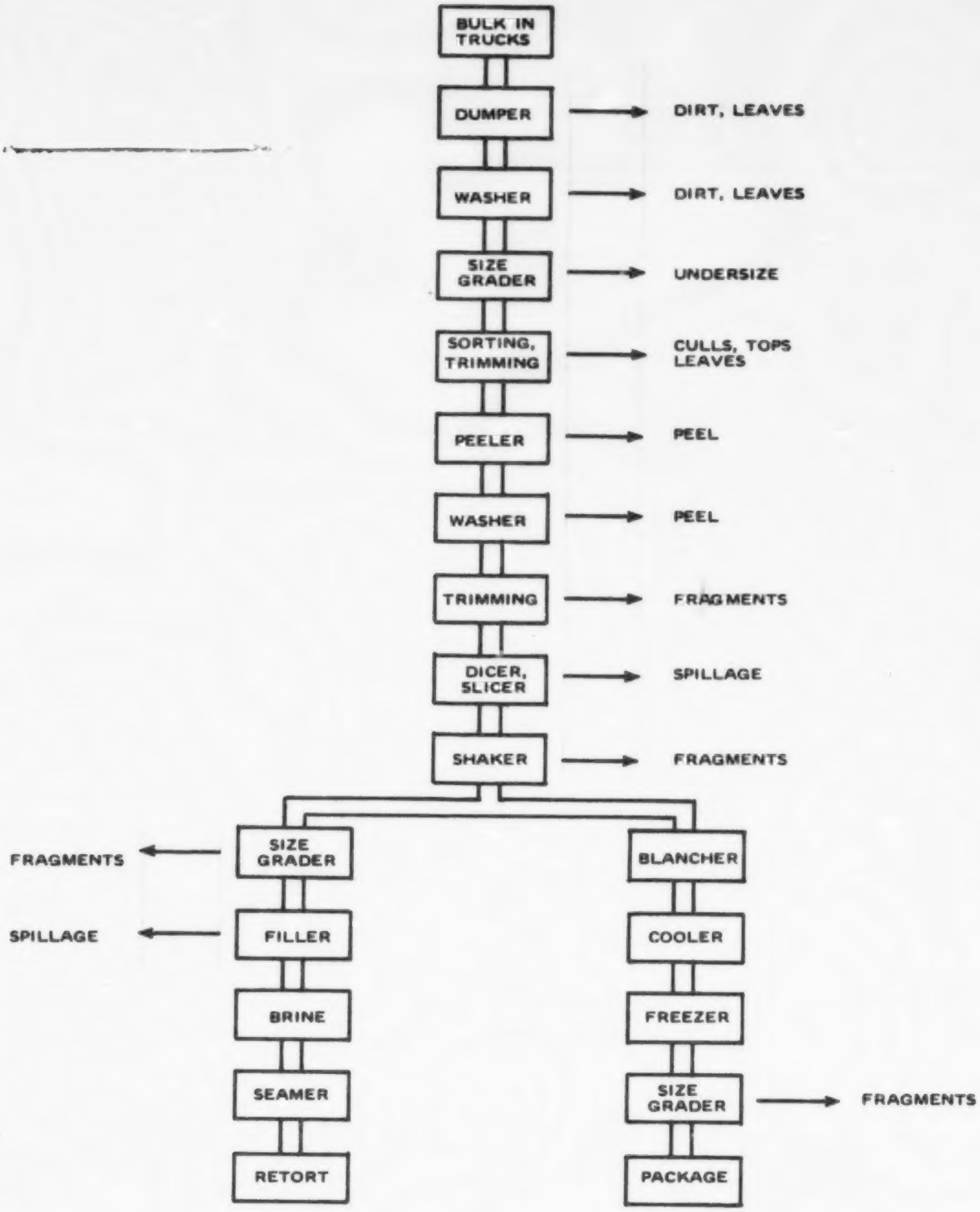

BULK IN TRUCKS
DUMPER
DIRT, LEAVES
WASHER
DIRT, LEAVES
SIZE GRADER
UNDERSIZE
SORTING, TRIMMING
CULLS, TOPS LEAVES
PEELER
PEEL
WASHER
PEEL
TRIMMING
FRAGMENTS
DICER, SLICER
SPILLAGE
SHAKER
FRAGMENTS
FRAGMENTS
SIZE GRADER
BLANCHER
SPILLAGE
FILLER
COOLER
BRINE
FREEZER
SEAMER
SIZE GRADER
FRAGMENTS
RETORT
PACKAGE

Figure 7. CARROTS -- process flow and sources of product residuals.

TABLE 19
MANAGEMENT OF CARROT RESIDUALS
A SUMMARY OF SITE-VISIT DATA

	Waste Source					
	Dirt Removal (Dry)	Washing	Peeling Washing	Trimming Sorting	Cutting Screening	Sorting
Number of Plants	5	9	13	13	11	10
In-plant Handling Method						
Continuous						
Dry				1		
Wet		2		1		
Wet & Dry						1
Containers	4			5	4	3
Gutters	1	7	13	8	7	7
On-site Storage Facility						
Pile	1					
Containers	2	1	1	3		1
Elevated Hopper		1	5	4	5	5
Truck	3	4	7	6	6	4
Other		3*				
By-product						
Feed						
Incidental Feed		1	5	8	7	7
Other						

Number of plants surveyed: 13

*Mud in washwater discharged to settling basin.

Corn

Harvesting and Delivery.

Corn is harvested by machines which strip the ears of corn from the stalks. The unusable portions of the plant (stalks and leaves) are left in the field as agricultural waste. The corn ears are loaded directly into trucks, which traverse the fields along side the harvesters, and are delivered directly to the processing plant.

At the processing plant, the corn is dumped in piles on a concrete accumulation pavement. Each load is processed within a period of a few hours from the time of delivery.

Product Preparation.

Air Cleaning. As the corn is conveyed into the plant, the ears are passsed through an air cleaner, an up-draft blower, which removes loose husks, leaves, and stalk fragments and deposits these onto a conveyor.

Husking and Trimming. The ears are manually introduced into husking machines which trim the ends of each ear and mechanically remove the husks and most of the adhering silk. Husks which fail to be removed by the huskers are manually separated at trimming tables. Obviously-unusable sections are also trimmed from the cob. The residual materials are deposited onto a common conveyor.

Washing. Washers with overhead sprays are employed to remove loosely-adhering silk, as well as dirt and other particles, from the corn.

Cutting. The kernels are removed from the cob by manually fed machines called cutters. The cobs are conveyed from the cutters by a dry or belt conveyor.

Silking and Cleaning. The kernels are passed through rotating or vibrating screens which, assisted by water, remove any remaining silk and kernel fragments. Extraneous debris, mainly kernel shells, is removed in flotation, or froth, cleaners. Kernel fragments and shells are further separated from the cut corn by shaker sieves and air cleaners, respectively. Defective kernels are manually removed from the product flow at an inspection belt. Residual materials from each of these operations are ultimately discharged into floor gutters.

Blanching and Cooling. Blanching of corn is only conducted prior to freezing. Hot-water blanchers are most frequently employed. Blanched corn is cooled in flumes; fragments are hydraulically removed during dewatering. The kernels are passed through a freezing tunnel prior to packaging.

Blending. Cream-style corn is formulated in batch mixing tanks by blending appropriate quantities of corn, starch, sugar and water.

The mixture is heated in holding tanks or by passage through tubular heat-exchangers prior to can-filling. Condiment bags are accumulated in containers; material adhering to the walls of the tanks are flushed into the gutter.

Filling. Whole-kernel and cream-style corn are placed into cans by automatic fillers. Cans of whole-kernel corn are filled with hot brine, passed through an exhaust box to remove entrapped air, and sealed for retorting. Spillage is common around filling operations.

Frozen corn can be placed directly into retail- and institutional-size packages, or into bulk tote-bins for repackaging at a later date.

Residuals Handling and Disposal.

The residuals from corn processing are handled both dry and in water.

Dry. Product residuals from the first air cleaners, the huskers, trimming tables and cutters are handled by drag and/or belt conveyors. These materials are ultimately collected on a single conveyor leading to a chopper. The materials are shredded by the chopper and discharged directly into trucks which are used to haul the waste to silos or ensilage stacks.

Wet. Product residuals hydraulically conveyed include materials from the washer, de-silking screens, flotation cleaners, shakers, final air cleaner and spillages from the preparation and final operation areas. These water-borne residuals are removed from the liquid effluent by screens and are conveyed to storage hoppers or bins. Ultimately, these materials are hauled together with the chopped product residuals and delivered to silos or ensilage stacks.

By-product. Product residuals generated by corn processing operations are utilized for animal feed, usually after conversion to ensilage.

Liquid Waste.

The major sources of liquid waste from corn processing operations are the washer, de-silking screens, and the flotation cleaner. In corn freezing operations the cooling flume which follows the blancher is also a major contributor.

Product conveyors between unit operations can be mechanical, pneumatic or hydraulic. Where flumes and pumping systems are utilized, these often generate the greatest volume of wastewater.

Blancher water is recirculated for extended periods, with fresh makeup water added to maintain the desired volume. The blancher is periodically drained and refilled. Although the total volume of wastewater from this source is not great, the organic load contained therein contributes significantly to the plant effluent.

The batch mixing and holding tanks used for blending cream-style corn are periodically rinsed out. Although the total amount of wastewater from this is also small, the organic load is significant.

Minor contributions to the wastewater volume and strength are generated at each of several points. These include husker and cutter lubricating sprays, and conveyor lubricating and washing sprays (where belts are employed). However, the cumulative contribution from these operations is significant.

All of the wastewater flows described above are collected in floor gutters and are ultimately consolidated. The composite flow is passed over screens to remove gross particulate matter and is discharged into a municipal sewer system or a company-operated land disposal system.

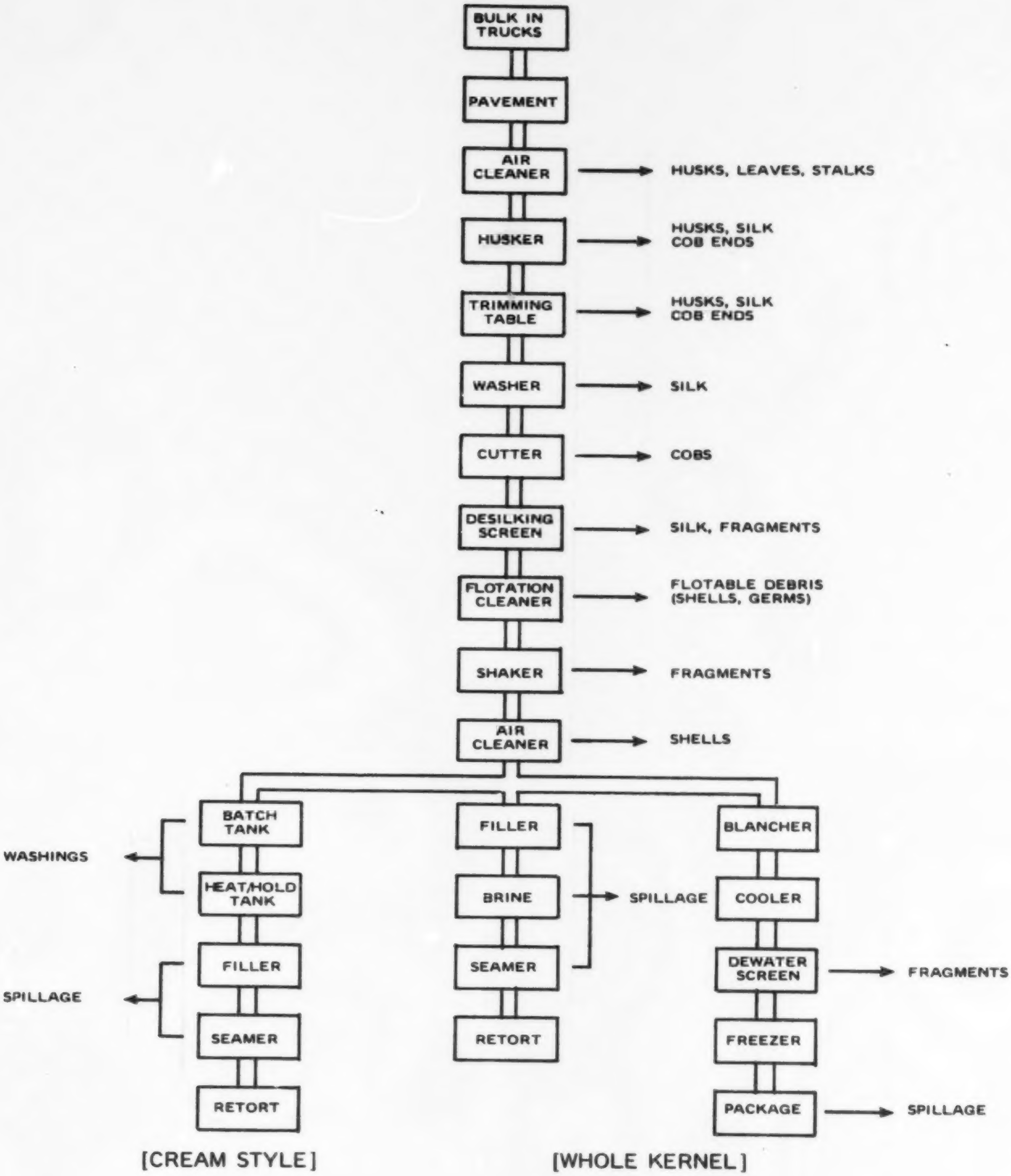

BULK IN TRUCKS
PAVEMENT
AIR CLEANER
HUSKS, LEAVES, STALKS
HUSKER
HUSKS, SILK COB ENDS
TRIMMING TABLE
HUSKS, SILK COB ENDS
WASHER
SILK
CUTTER
COBS
DESILKING SCREEN
SILK, FRAGMENTS
FLOTATION CLEANER
FLOTABLE DEBRIS (SHELLS, GERMS)
SHAKER
FRAGMENTS
AIR CLEANER
SHELLS
BATCH TANK
HEAT/HOLD TANK
WASHINGS
FILLER
SEAMER
SPILLAGE
RETORT
FILLER
BRINE
SEAMER
SPILLAGE
RETORT
BLANCHER
COOLER
DEWATER SCREEN
FRAGMENTS
FREEZER
PACKAGE
SPILLAGE
[CREAM STYLE]
[WHOLE KERNEL]

Figure 8. CORN -- process flow and sources of product residuals.

TABLE 20
MANAGEMENT OF CORN RESIDUALS
A SUMMARY OF SITE-VISIT DATA

	Waste Source						
	Pneumatic Cleaning	Husking	Trimming Sorting	Cutting	Washing	Hydraul. Convey.	Sorting
Number of Plants	11	18	14	18	16	15	6
In-plant Handling							
Method							
Continuous							
Dry	11	18	13	17			
Wet						1	
Wet & Dry				1			
Containers			2		1	1	2
Gutters			1		16	14	4
On-site Storage							
Facility							
Pile	1	1		1	1	1	1
Containers							
Elevated Hopper		3	4	3	7	8	3
Truck	9	13	10	13	7	5	1
Other*	1	1		1	1	1	1
By-product							
Feed**	11	18	14	18	13	11	4
Incidental Feed							
Other							

Number of plants surveyed: 18

* One visited plant conveyed its product residuals directly to an adjacent feed lot.

**One of the visited plants maintained its own feedlot.

Peas

Harvesting and Delivery.

Peas for processing are currently all mechanically harvested. The cut vines are either hauled to nearby viner stations, or are picked up from windrows and threshed by mobile field viners. The peas are air-cleaned, screened and discharged into field bins or trucks and hauled to the processing plant. The vines and pods from the viner stations are generally converted to silage for later use as animal feed. The vines and pods which are discharged in the fields by mobile viners are generally baled and used as animal feed.

Harvesting and processing schedules are closely coordinated to minimize delays and thereby assure maximum achievable product quality. Therefore, only minimal facilities, if any, are provided for product storage at the plant.

Product Preparation.

Dumping. Peas in bins are dumped directly onto a conveyor belt or into small hoppers. Peas in bulk lots are dumped into larger receiving hoppers or are pneumatically removed from the trucks. The delivered product is processed with minimal delay.

Cleaning. The peas are first passed through an up-draft air cleaner. Lightweight materials, such as leaves, vines, pods and pea shells are pneumatically removed. Further separation of unusable materials is made with a perforated table shaker.

Washing. The peas are thoroughly washed in special flood washers. The dirt and pea shells (skins) which are removed during the washing are discharged into the floor gutter with the overflow effluent. The peas are dewatered and given a final rinse.

Size Grading. Perforated steel cylinders are used to separate the peas into several size categories. Peas within each category are collected in a separate hopper. Generally, separate and parallel units are subsequently provided for each of these product streams. Undersized peas are discarded.

Blanching and Cooling. Peas are blanched in boiling water to inactivate the enzymes. The blanched peas are cooled while being conveyed in flumes. Only soluble solids are lost during blanching.

Quality Grading. The peas are quality graded by brine separation. Since the specific gravity of peas is influenced by the starch content, the concentration of the brine is adjusted to take advantage of the density differential to accomplish quality separation. Overly mature peas which are separated by this process are discarded.

Inspection. The peas are passed through an up-draft air cleaner to remove skins which may have been loosened during the previous operations. The product is visually examined and unacceptable peas are manually removed.

Filling. The peas are discharged into a small hopper which gravity-feeds into filling machines. The cans are filled with product, topped with hot brine, sealed and retorted. Product spillages are common around fillers and seamers.

Freezing and Packaging. The peas are distributed over a steel-mesh conveyor belt and passed through a freezer. The frozen peas are placed directly into consumer-sized packages or into large plastic-lined storage cartons for later repacking. Minimal spillages occur during packaging and repackaging.

Residuals Handling and Disposal.

Product residuals from pea processing are handled both dry and in water.

Dry. Most frequently, all residuals from pea processing are hydraulically conveyed. However, in some plants the materials removed by the initial air cleaner and shaker are handled dry. The leaves, vines and pods are collected in containers or on conveyor belts and discharged into waste hauling trucks. Additionally, a few pea processors are implementing ‘‘dry’’ pre-cleanup procedures. Spilled product is swept from the floors and deposited into containers, or is picked up with vacuum hoses and conveyed pneumatically from the plant, prior to general plant cleanup with water hoses.

Wet. Residuals generated by washing, size grading, quality grading and inspection are generally discharged into the gutter system. Wastewater from these units is used to convey residuals so discharged from the processing areas. The residuals from the initial air cleaner and shaker are most frequently deposited into the gutter and hydraulically conveyed from the receiving area. Product spillages are also periodically swept or hosed into gutters.

These materials are consolidated at a central point and removed from the liquid waste by screens. The screened solids are discharged into a permanent hopper or directly into waste hauling trucks.

By-products. All residuals from pea processing are generally fed to animals. Where this utility is not feasible, the materials are disposed of by landfill or spread-and-cover techniques.

Liquid Waste.

Large quantities of water are used during pea processing to wash, blanch and cool the product, to lubricate and clean equipment, to operate freezer condensing equipment, and to transport product and residual materials. To minimize consumption, water is reused extensively within most plants.

The major volumetric sources of liquid waste include product fluming and pumping systems, washers, blanchers and coolers, and freezer condensers. Minor contributions are made by lubricating and cleaning sprays provided at each conveyor belt and most equipment. Significant contributions to the organic load include washers, blanchers and coolers.

All wastewaters are discharged into floor gutters. The various streams are ultimately consolidated and passed over a screen to remove gross particulate matter. The screened effluent is most frequently discharged to a company-operated treatment or disposal facility (oxidation ponds, aerated lagoons, spray irrigation) or in a few cases to the municipal sewer system.

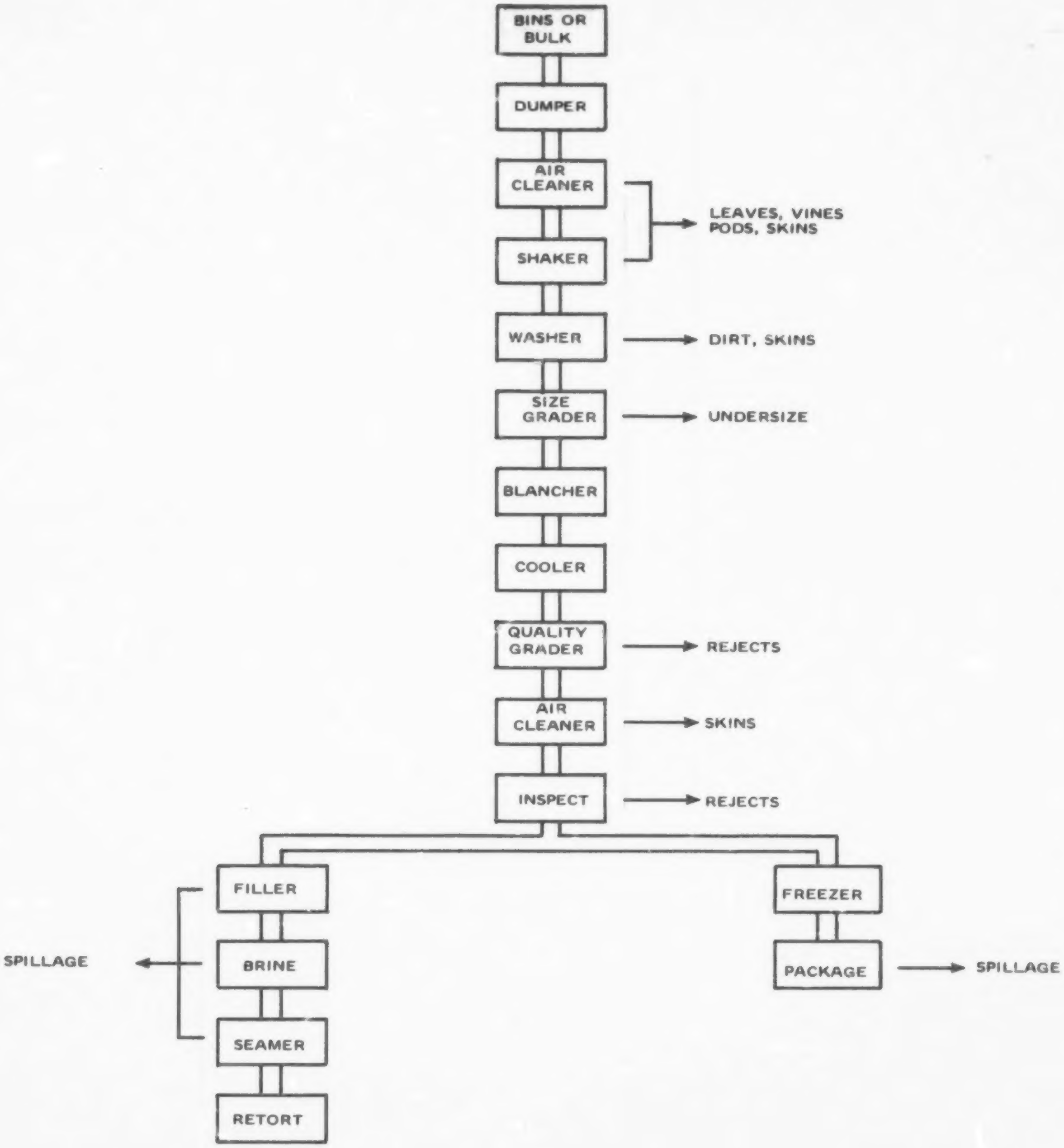

BINS OR BULK
DUMPER
AIR CLEANER
SHAKER
LEAVES, VINES PODS, SKINS
WASHER
DIRT, SKINS
SIZE GRADER
UNDERSIZE
BLANCHER
COOLER
QUALITY GRADER
REJECTS
AIR CLEANER
SKINS
INSPECT
REJECTS
FILLER
BRINE
SEAMER
RETORT
SPILLAGE
FREEZER
PACKAGE
SPILLAGE

Figure 9. PEAS -- process flow and sources of product residuals.

TABLE 21
MANAGEMENT OF PEA RESIDUALS
A SUMMARY OF SITE-VISIT DATA

	Waste Source						
	Pneumatic Cleaning	Mechanical Cleaning	Washing	Froth Cleaning	Size Grading	Quality Grading	Sorting
Number of Plants	20	17	20	9	3	9	21
In-plant Handling							
Method							
Continuous							
Dry	3	2					
Wet	1		2	1		1	
Wet & Dry							
Containers	4	3	2	1	1	1	8
Gutters	12	14	16	7	2	7	20
On-site Storage							
Facility							
Pile							
Containers	4	1	3	2	1	1	4
Elevated Hopper	9	8	12	4	2	7	13
Truck	7	8	4	3		1	6
Other*			1				1
By-product							
Feed	15	13	14	6	2	8	16
Incidental Feed							
Other							

Number of plants surveyed: 21

*Residuals discharged with liquid waste.

Sweet Potatoes

Harvesting and Delivery.

Sweet potatoes for processing are harvested by hand or machine. They are placed into baskets or tote bins, which are in turn loaded onto trucks or wagons, and hauled to the processing plant. When processing schedules necessitate delays of up to several days, the containers are stacked in well ventilated and sheltered storage areas. When prolonged delays are anticipated, the sweet potatoes are placed in a ventilated warehouse which is maintained at a temperature between 60 F and 65 F.

Some plants are equipped to receive sweet potatoes in bulk lots on trucks. When processing delays are anticipated, these potatoes are transferred into crates or hampers and stored as described above.

Product Preparation.

Cleaning and Washing. The potatoes are dumped into a dry cleaner (revolving reel) or grader where sand, dirt, culls, and other foreign material are separated. In the last half of the reel sprays are generally provided to remove the remaining adhering soil or sand from the potatoes.

Peeling. The sweet potatoes are usually preheated before peeling to help eliminate discoloration of the surface of the raw sweet potato between peeling and closing operations. After preheating the potatoes are conveyed through a caustic bath and then passed under high pressure overhead sprays in a large revolving reel. The water sprays, coupled with the friction of the sweet potatoes tumbling against each other, loosen the skins which are then washed away. The potatoes are washed free of all caustic during this process.

Sorting and Trimming. The peeled potatoes are deposited onto inspection belts. Unacceptable potatoes are manually removed and discarded; blemished areas are trimmed from sweet potatoes which are otherwise acceptable. The irregularly shaped and oversized potatoes are manually separated at this point. These are diverted to the solid pack, or pureed, style operations.

Size Grading. The peeled potatoes are mechanically sorted into several sizes for uniformity of final product. The smaller potatoes are used for the whole pack styles; the larger ones are halved or cut into smaller pieces for other style packs. A minimal quantity of product is lost to spillage at the size graders.

Filling. Sweet potatoes for the whole pack style are manually placed into cans; potatoes for other pack styles are filled into cans by machines. The cans are then filled with syrup, passed through an exhaust box to remove entrapped air, and sealed for retorting. Product spillages inevitably occur at fillers.

Residuals Handling and Disposal.

Product residuals from sweet potato processing are handled both dry and in water.

Dry. The sand, dirt, cull and extraneous materials separated from the product flow by the dry cleaner (revolving reel) are collected in containers or on a conveyor belt. These residuals are deposited into a waste hauling truck.

Residuals from the sorting and trimming tables, the size graders and from the cutters are collected in containers or on conveyor belts. These materials are deposited into a separate waste hauling truck.

Wet. Sand and dirt washed from the delivered sweet potatoes are discharged with the washer wastewater into the floor gutter. The potato skins removed at the reel washer are also discharged into the gutter system. Spillages which occur at various points throughout the plant are periodically swept or hosed into gutters.

These residuals are conveyed in the wastewaters which are discharged from various units. These streams are ultimately consolidated and screened. The solids removed by the screens are deposited into a permanent hopper or directly into the truck with the culls and trimmings.

By-products. The product residuals are frequently fed to livestock. Where this utilization is not feasible, these materials are hauled to sanitary landfill sites for disposal.

Liquid Waste.

The major sources of wastewater from sweet potato processing are the raw vegetable washer and the rinse sprays following the caustic peeler. Minor volumetric contributions are made by lubricating sprays provided for each conveyor belt and other pieces of equipment. Significant volumes of water are used to periodically hose spilled product into the gutters, as well as to clean the equipment.

These flows are consolidated and screened to remove gross particulates. The screened effluent is then discharged into a municipal sewer system or to a company-operated treatment facility.

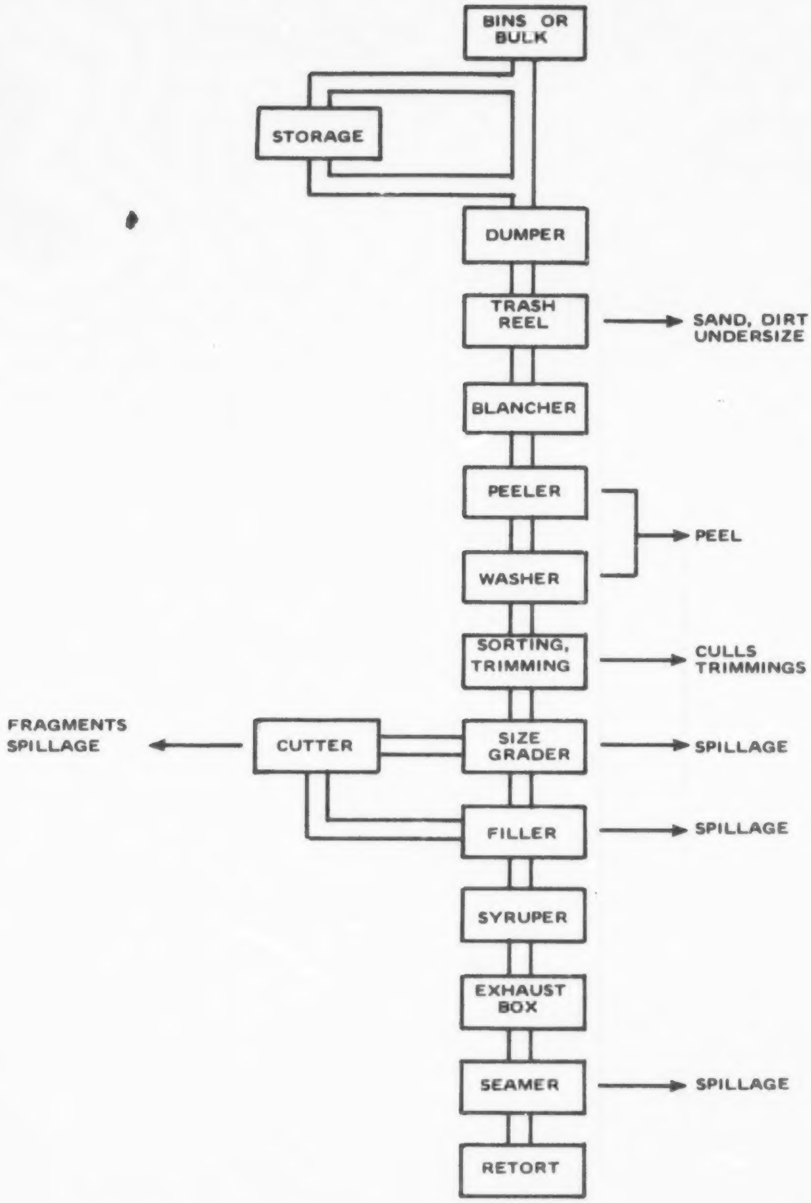

BINS OR BULK
STORAGE
DUMPER
TRASH REEL
SAND, DIRT UNDERSIZE
BLANCHER
PEELER
WASHER
PEEL
SORTING, TRIMMING
CULLS TRIMMINGS
FRAGMENTS SPILLAGE
CUTTER
SIZE GRADER
SPILLAGE
FILLER
SPILLAGE
SYRUPER
EXHAUST BOX
SEAMER
SPILLAGE
RETORT

Figure 10. SWEET POTATOES -- process flow and sources of product residuals.

White Potatoes

Harvesting and Delivery.

Potatoes for processing are mechanically harvested, preferably after an extended growing season which produces a tuber with higher specific gravity and low reducing sugar. Harvesting production far exceeds the capacity of processing plants, so much of the crop must be stored for weeks or months. Because potatoes can be successfully stored many plants operate ten or twelve months a year.

It is not unusual to transport raw potatoes considerable distances for processing. Bulk containers are shipped by truck or rail car and are unloaded into temporary storage bins or are sent directly to processing.

White potatoes are processed into a variety of styles. These include french fries, hash brown, flakes, starch, chips and small whole. The production of each style requires different operations; processing plants generally limit their output to one or two styles. The following discussion is limited to the description of french fries production.

Product Preparation.

Transporting, Washing. Temporary storage in large capacity plants may be in stationary concrete bins. The large bulk lot of potatoes is hosed into a flume in the floor of the bin and conveyed by the water to a large-mesh metal conveyor situated over a sump. The initial wash water with most of the field soil and some vines drop through the conveyor and is pumped to a large settling pond. The potatoes are mechanically conveyed to a drum-type washer equipped with high pressure sprays. The potatoes tumble through the washer where the tumbling action and the high pressure water remove practically all of the adhering field soil. The wash water may be reused in the initial fluming and washing operations or discharged directly to the settling pond.

Sorting. The potatoes are discharged to a sorting belt where culls and trash are manually removed to bins.

Peeling, Washing. Peeling is accomplished in an abrasion, steam or lye peeler. The type of peeler depends primarily on the style of the finished product, but most of the potatoes are peeled with lye. After application of the lye solution the loosened peel is removed by brusher and water sprays. Thorough rinsing is necessary to prevent hardening and discoloration of the peeled surface. The peel is discharged to the gutter with the wash and rinse water for disposal.

Trimming, Sorting. The peeled potatoes are discharged from the washer to a belt and trimmed to remove unpeeled eyes and discolored areas. Small potatoes may be removed for processing into other styles. The trim material is discarded to the gutter for disposal.

Cutting. After trimming, the potatoes are cut into one of several styles, and the cut units are sent over a perforated shaker which removes small pieces. The small pieces may be diverted to other styles or discarded to the gutter as waste. The cut units are washed to remove starch from the cut surfaces, and then water blanched.

Blanching. Water blanching serves to improve the quality of the finished product. Nearly all of the waste produced here is in liquid form. The cut units are flumed to a perforated shaker and dewatered.

Frying. The cut units are dried by hot air while being conveyed on a mesh belt to a deep fat fryer. They are carried through the fryer and then sent over a perforated shaker where excess fat is removed and recovered.

Freezing and Packaging. The potatoes are frozen in a belt freezer and discharged over a perforated shaker to remove small pieces which are discarded to the gutter. The frozen product is packaged directly into consumer- and institutional-sized cartons, or filled into large plastic-lined cartons for later repackaging.

Residuals Handling and Disposal.

The residuals from white potato processing are handled either wet or dry, some of which are discarded and others used in by-products.

Dry. Culls and trash are collected in bins and dumped onto a truck for some type of land disposal, or are used in by-products.

Wet. Waste materials from the peeler and washer, the slicer, and incidental spillage from shakers and conveyors are flushed to the gutter, flumed to a sump, pumped over a screen and the solid material collected in a hopper. A significant quantity of insoluble potato solids are in the form of finely divided particles and are not retained by the screen.

By-products. Significant quantities of potato waste are mixed with other feed materials and fed to animals.

Liquid Waste.

Food processing plants use large quantities of water to wash, peel, blanch and cool the product, lubricate and clean equipment, operate freezing equipment and to transport residual materials to on-site collection and storage facilities. For conservation of water and efficiency of operation, water is reused as far as practicable, and finally used to transport residual materials.

Major sources of liquid waste include transporting product in flumes, washing, blanching, and cooling, and operating freezer condensing equipment.

Major sources of dissolved organic matter include product washing, peeling and rinsing, transporting in flumes, blanching and cooling, and transporting residuals.

Minor sources of liquid waste include continuous or intermittent washing of belts and equipment, usually by sprays, to assure a clean and efficient operation.

Liquid waste is thoroughly screened to remove solid material and is then discharged to disposal systems. Because of the high concentration of suspended solids contained in the screened effluent, many processors provide additional treatment facilities. The screened wastewater is discharged into large clarifiers in which settleable solids are removed. The resultant sludge is pumped to a vacuum filter where the solids are removed as a thick slurry. The filtered wastewater is generally returned to the clarifier, the overflow from which is discharged to a treatment or disposal system (lagoons, oxidation ponds, spray irrigation).

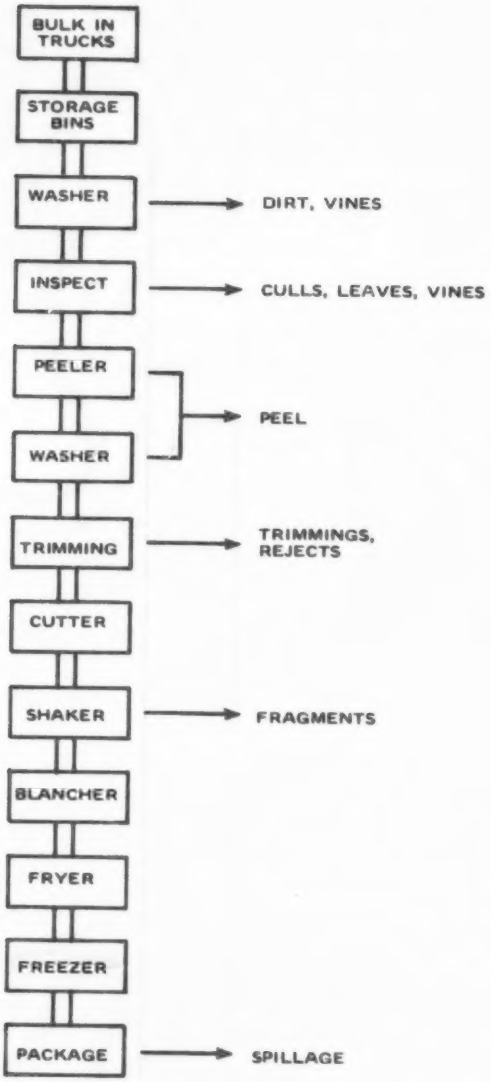

BULK IN TRUCKS
STORAGE BINS
WASHER
DIRT, VINES
INSPECT
CULLS, LEAVES, VINES
PEELER
WASHER
PEEL
TRIMMING
TRIMMINGS, REJECTS
CUTTER
SHAKER
FRAGMENTS
BLANCHER
FRYER
FREEZER
PACKAGE
SPILLAGE

Figure 11. WHITE POTATOES (french fries) -- process flow and sources of product residuals.

TABLE 22
MANAGEMENT OF WHITE POTATO RESIDUALS
A SUMMARY OF SITE VISIT DATA

	Waste Source						
	Fluming Washing	Trash Removal	Peel-ing	Trim-ming	Sort-ing	Dry-ing	Fragment Removal
Number of Plants	5	7	8	5	8	2	6
In-plant Handling Method							
Continuous							
Dry		3					1
Wet	5			1	1		
Wet & Dry		1					
Containers		2			2	2	1
Gutters		1	8	5	6		4
On-site Storage Facility							
Pile			1	1	1	1	1
Containers		3				1	1
Elevated Hopper			3	3	3		2
Truck		4	4	1	4		2
Other	4*						
By-product							
Feed		5	5	5	5	2	5
Incidental Feed					1		
Other							

Number of plants surveyed: 8

*Mud and residuals in fluming and washwater discharged to settling ponds.

Pumpkin/Squash

Harvesting and Delivery.

Depending on the geographic region, the variety and the time of season, pumpkin may be harvested entirely by hand or entirely by machine. In either case, the produce is cut from the vines which are left in the field. The pumpkins are loaded directly onto open-top trucks or into bins which are loaded onto flat-bed trucks. Delivery to the processing plant is made immediately after each truck is filled to capacity.

The bins are unloaded at the plant and stacked in the receiving area. The pumpkins in bins are dumped onto conveyors. Bulk-loaded trucks unload the produce in one of two ways. The pumpkins are most frequently dumped onto the pavement in the receiving area. These are left in piles until they can be metered into the processing plant. Conveyance into the plant is generally by belts via a front loader-tractor. An alternate unloading procedure is into large hoppers. From here the pumpkins are conveyed either directly into the plant or to storage bins. Conveyance is generally by belt, although flumes are also used.

Product Preparation.

Washing. Pumpkins conveyed into the plant are first passed through a reel washer. Dirt, leaves and vines are washed from the product during this operation. Additionally, seeds and seed-cavity fibers are washed from pumpkins which have been cracked during harvesting, transporting or unloading.

Trimming. The vine ends are manually trimmed from the pumpkins and discarded. In some plants, the pumpkins are also split at this operation and much of the seeds are manually removed.

Chopping. The pumpkins are passed through a mechanical chopper which reduces each pumpkin into relatively large fragments. Generally, no residuals are produced at this point.

Washing and Seed Removal. The large pumpkin fragments are passed through a second reel washer. High-pressure sprays are employed to separate most of the seeds and much of the seed-cavity fibers. Small fragments of pumpkin are also lost at this operation.

Inspection. The washed fragments are visually inspected while being transported on conveyor belts. Leaves, vines, seeds and other debris, as well as unusable product, are manually removed from the process flow.

Wilting. To facilitate extraction of the usable pumpkin solids, the fragments are subjected to a steam atmosphere, a step commonly referred to as wilting. Depending upon the type of equipment used, some soluble solids may or may not be lost. Some plants utilize a dewatering screen following the wilter. In such operations, a small quantity of solids are removed by the draining of excess moisture.

Pressing and Centrifuging. These are operations used by a few plants to produce a final product with higher solids. The wilted pumpkin is passed through a continuous press which squeezes much of the moisture from the product. The liquid effluent, which is high in suspended solids, is collected and passed through a centrifuge. The solids which are so collected are returned to the product flow; the liquid is discharged as wastewater.

Pulping and Finishing. To produce a final product of the desired texture, the wilted pumpkin or the solids recovered from the press and centrifuge are first forced through a relatively coarse screen (pulper), followed by forced passage through a finer screen (finisher). The residual from the pulper contains seeds, skin, coarse fiber and similar materials; the material rejected by the finisher consists primarily of fiber and fine particulates.

Blending and Heating. To obtain product of a desired consistency, the solids are collected in batch tanks and blended. Spices are added at this point, if desired. The mix is then heated, generally by passage through swept-surface heat exchangers.

Filling (canning). The heated product is placed into cans by piston fillers. The cans are then sealed for retorting. Minimal amounts of spillage occur at the filling and seaming operation.

Cooling and Filling (freezing). Product for freezing is cooled with swept-surface heat exchangers. The cooled product is then placed into consumer cartons with piston fillers. The packages are then wrapped for freezing. The cooling process generates no residuals but some spillage does occur at the filler.

Residuals Handling and Disposal.

Product residuals from pumpkin processing operations are handled both dry and wet.

Dry. Trimmings removed at the trim table and residual material removed from the process flow at the inspection belt are generally deposited directly into containers or onto conveyors which empty into portable hoppers. These containers are in turn emptied into hauling trucks for ultimate disposition, generally as livestock feed.

Residuals ejected by the pulper and finisher are generally accumulated in portable hoppers or similar containers. These materials are also emptied into hauling trucks, generally for use as livestock feed.

Wet. The residuals conveyed from the reel washer in the washer wastewater are generally screened before this flow is permitted to mix with other wastewaters. The seeds, with much of the seed-cavity fibers still adhering, are removed and collected in bins. The seeds are utilized for seed stock and for human consumption as a snack item. Fibers and fragments which pass through the screen are discharged in the plant effluent.

The liquid discharge from the centrifuge, the rinsing of the batch mixing tanks, and spillages at fillers and other equipment each contributes a significant quantity of suspended solids which are discharged with the plant effluent. At some plants, the ejected material from the pulper and finisher may be dumped into the gutter system. Altough the effluent stream is generally screened to remove particulates in excess of 20-mesh, most of these fine particles are carried from the plant in the wastewater discharge.

By-products. The pumpkin seeds which are recovered from the reel washers and trimming tables are utilized for seed stock and for human consumption as a snack item.

Product residuals which are collected in containers are combined with the material recovered by screens from the wastewater effluent and are generally fed to livestock.

Liquid Waste.

The largest volume of wastewater originating from pumpkin processing operations is attributable to the reel washers. Generally, fresh water is utilized in these washers and discharged after a single use.

Smaller volumetric contributions are made by the wilter (where the wilter condensate is allowed to drain), the wilter press centrifuge where employed, and the cooler in freezing operations. Except for cooling water, these sources contain high concentrations of dissolved and suspended solids, which for the most part are discharged with the screened effluent. The cooling water, being relatively clean, is generally reused in the other operations within the plant.

All the above wastewater streams are consolidated and screened to remove gross particulate matter. The screened effluent is then discharged into a municipal sewer system or a company-operated system, most frequently spray irrigation. Where lagoons are utilized, the wastewater is often first discharged into smaller basins. The fine suspended solids tend to rise rapidly, forming a dense surface layer which is skimmed off. These solids are collected and disposed of on land.

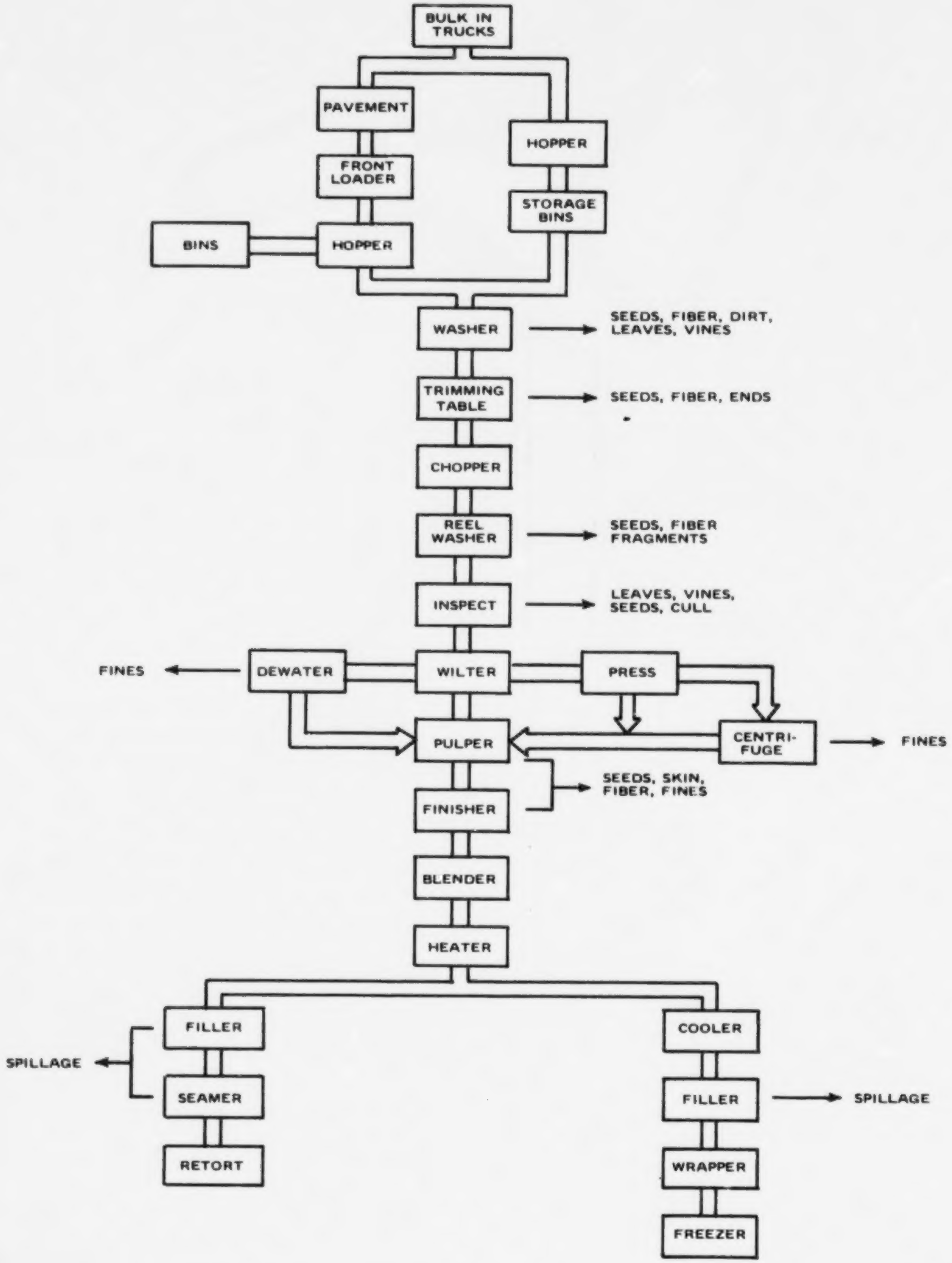

BULK IN TRUCKS
PAVEMENT
HOPPER
FRONT LOADER
STORAGE BINS
BINS
HOPPER
WASHER
SEEDS, FIBER, DIRT, LEAVES, VINES
TRIMMING TABLE
SEEDS, FIBER, ENDS
CHOPPER
REEL WASHER
SEEDS, FIBER FRAGMENTS
INSPECT
LEAVES, VINES, SEEDS, CULL
FINES
DEWATER
WILTER
PRESS
PULPER
CENTRIFUGE
FINES
SEEDS, SKIN, FIBER, FINES
FINISHER
BLENDER
HEATER
FILLER
COOLER
SPILLAGE
SEAMER
FILLER
SPILLAGE
RETORT
WRAPPER
FREEZER

Figure 12. PUMPKIN/SQUASH -- process flow and sources of product residuals.

TABLE 23
MANAGEMENT OF PUMPKIN/SQUASH RESIDUALS
A SUMMARY OF SITE-VISIT DATA

	Waste Source				
	Trash Removal	Dirt Removal	Seed Separation	Pulping Finishing	Sorting
Number of Plants	3	2	5	6	5
In-plant Handling Method					
Continuous					
Dry			2	3	2
Wet			3		
Wet & Dry					
Containers				1	2
Gutters	3	2		2	1
On-site Storage Facility					
Pile					
Containers	1		5	3	4
Elevated Hopper	1			2	
Truck	1	2		1	1
Other					
By-product					
Feed					
Incidental Feed	3	1		5	4
Other*			4		

Number of plants surveyed: 6

*Other by-product: pumpkin seeds for seed stock and human consumption.

Spinach/Greens

(Leaf Vegetables)

Harvest and Delivery.

Spinach and greens for processing are almost exclusively harvested by machines. The plants are cut, loaded directly into trucks and hauled immediately to the processing plant. Because these vegetables are highly susceptible to wilting, the produce is processed within a relatively short time after delivery.

Product Preparation.

Unloading. The trucks which deliver spinach or greens to the processing plant are unloaded directly onto belt conveyors which transport the produce to the processing area. The vegetables are most frequently unloaded manually with pitchforks, although mechanical devices are utilized by some plants. Some loss due to spillage is incurred during this operation.

Soil Removal. Clumps of soil are inevitably picked up during the machine-harvesting process. Much of this is delivered to the processing plant with the vegetables. These soil clumps, together with dust, weeds and leaf fragments, are removed from the product stream by rotating screens, commonly referred to as trash reels.

Initial Inspection. The product stream is frequently visually inspected after the trash reel. Weeds and other plant debris, as well as discolored leaves, are manually removed; produce with adhering roots are trimmed.

Washing. Leaf vegetables are washed by immersion in a series of two or three tanks. Agitation of the product in and movement through the tanks may be by high pressure overhead sprays supplied with recirculating water, or by revolving paddles. The product is removed from the final wash tank by steel-mesh conveyors. Fresh-water rinse sprays may be employed over the belt to provide final rinsing. Dirt washed from the leaves is continuously discharged into the gutter system with the relatively high rate of overflow provided.

Blanching. Spinach and leafy greens are blanched by either hot water immersion or by steam. Water blanchers are equipped with paddles to keep the produce immersed while facilitating transport of the product through the unit. Steam blanching is accomplished by placing the produce on steel-mesh conveyors which pass through a chamber saturated with steam. Soluble solids are leached from the product by either method and are discharged with the overflow or condensate, respectively.

Cooling. Only leafy vegetables being prepared for freezing are cooled after blanching. Flumes or overhead sprays are utilized for this purpose. Soluble solids are lost from the product during this operation. Leafy vegetables for canning continue along the process flow in a hot state.

Final Inspection. The product stream is visually inspected and unacceptable materials are manually removed prior to filling and/or packaging.

Filling and Brining. Leafy vegetables are manually placed into cans. The cans are then filled with a hot brine solution. Larger sized cans are passed through an exhaust box prior to sealing. Spillages occur during the filling operation.

Packaging. Leafy vegetables for the whole-leaf style are manually placed into retail-sized cartons. These cartons are check-weighed, adjustments are made as required, and the packages are closed, wrapped and sent to the freezer. Spillage is common at both the filling and check-weighing operations.

Cutting. The cut-style of leafy vegetables is produced by passing blanched produce through a chopper. The cut leaves are manually placed into cans or packages and follow the process flow described above. Minimal product losses occur at the unit.

Residuals Handling and Disposal.

Product residuals generated during leafy vegetable processing are handled both dry and in water.

Dry. Residual materials discarded by the trash reel and at the initial inspection are normally handled dry. Conveyor belts are frequently provided to transport these materials to portable containers or directly to waste hauling trucks. In many plants the material discarded by the trash reel is allowed to accumulate on the floor and is periodically shoveled into containers which are subsequently emptied into hauling trucks. Manually discarded material from the initial inspection station is normally placed into containers.

Wet. Residual materials from other operations consist mainly of spilled product. These are periodically swept or hosed into the gutter system. These materials are removed by screening and stored in portable containers, permanent hoppers, or in the waste hauling truck.

By-products. Residuals generated at operations subsequent to washing are recovered from the plant effluent by screens. These materials consisting exclusive of produce, are frequently fed to livestock. Residuals removed by the trash reel contain a significant quantity of dirt and, thereby, have no utility. These materials are disposed of in landfill or spread-and-cover operations.

Liquid Waste.

The major sources of wastewater from leafy vegetable processing are the washing, blanching and cooling operations. Water within each operation is extensively recirculated, but a relatively high replacement rate is provided. The overflows from these units are used to convey residuals which are discharged into the gutters from the processing areas.

The plant effluent is normally screened to remove gross particulates from the wastewater stream. The screened effluent is then discharged into a company-operated treatment system or to a municipal sewage treatment system.

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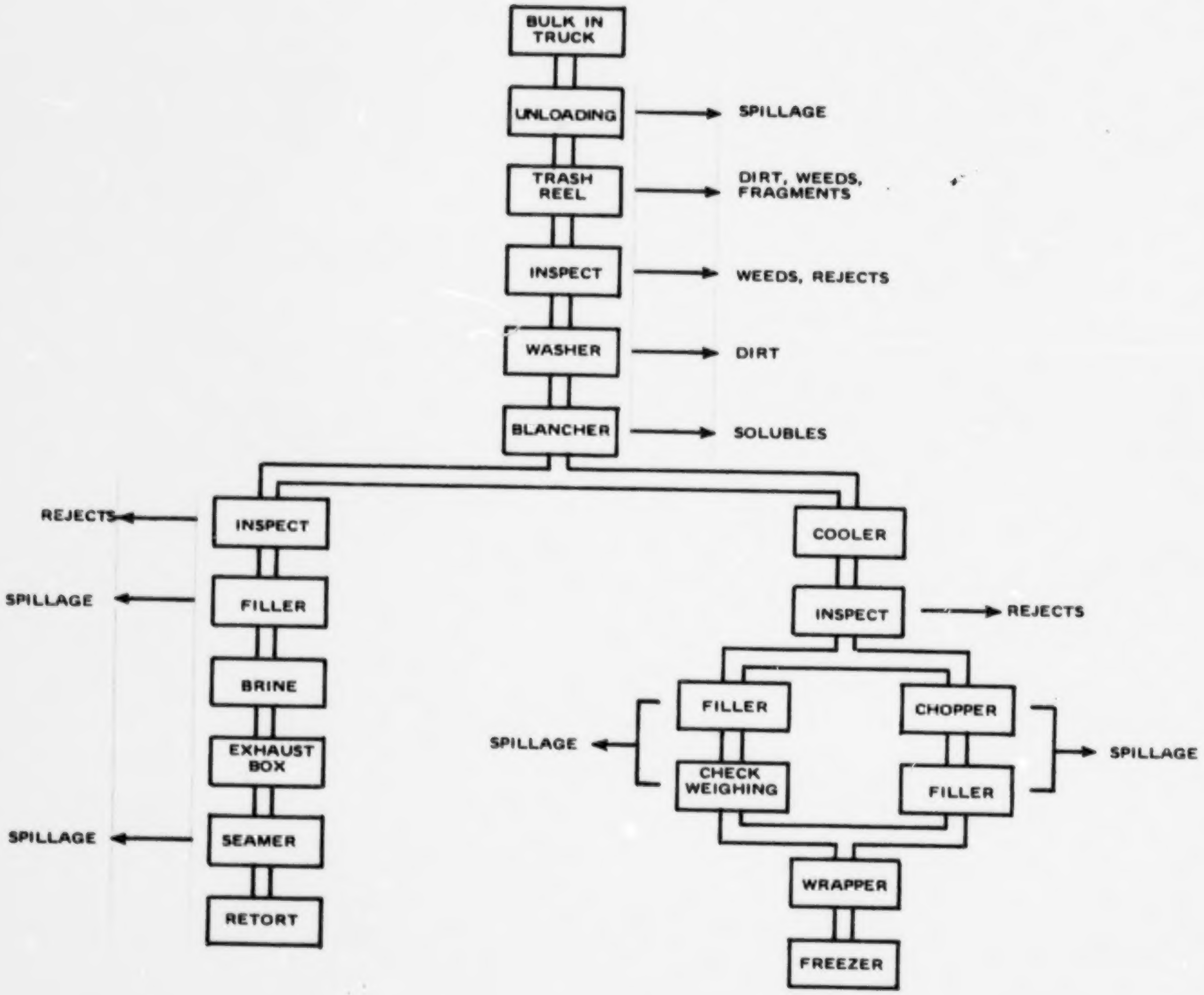
BULK IN TRUCK
UNLOADING
SPILLAGE
TRASH REEL
DIRT, WEEDS, FRAGMENTS
INSPECT
WEEDS, REJECTS
WASHER
DIRT
BLANCHER
SOLUBLES
REJECTS
INSPECT
COOLER
SPILLAGE
FILLER
INSPECT
REJECTS
BRINE
FILLER
CHOPPER
SPILLAGE
EXHAUST BOX
CHECK WEIGHING
FILLER
SPILLAGE
SPILLAGE
SEAMER
WRAPPER
RETORT
FREEZER

Figure 13. SPINACH/GREENS -- process flow and sources of product residuals.

TABLE 24
MANAGEMENT OF SPINACH/GREENS RESIDUALS
A SUMMARY OF SITE VISIT DATA

	Waste Source			
	Trash Removal	Sorting (Initial)	Washing Blanching	Sorting (Final)
Number of Plants	18	17	18	18
In-plant Handling Method				
Continuous				
Dry	4	1		
Wet				2
Wet & Dry	1	4		1
Containers	6	6		6
Gutters	7	6	18	11
On-site Storage Facility				
Pile				
Containers	6	3		
Elevator Hopper	6	8	12	13
Truck	5	5	4	4
Other*	1	1	2	1
By-product				
Feed	1	1		
Incidental Feed	13	12	10	12
Other				

Number of plants surveyed: 18

*Residuals discharged with liquid waste.

Tomatoes

Harvesting and Delivery.

Tomatoes for processing are predominantly hand harvested. However, in California, the tomatoes are mainly machine harvested. This has become commercially practicable through engineering of equipment and the development of crack-resistant varieties which mature a high percentage of crop at one time. The vines are cut off at the ground and carried into the machine where a separator shakes off ripe tomatoes. They drop to a conveyor belt where they are manually sorted and are then conveyed to half-ton capacity bins which are on a trailer being towed parallel to the mechanical harvester.

The tomatoes are hauled to the cannery by truck trailer and usually processed soon after harvest. The time between harvesting and processing is minimized as far as possible. Scheduling of field operations must be closely coordinated with the requirement and capacity of the plant. It is desirable to leave the tomatoes in the field unharvested rather than to hold them in bins for prolonged periods.

Product Preparation.

Dumping. The tomatoes are dumped directly to tanks of water or large flumes to remove adhering field soil. The water is agitated by pump to direct the flow toward one end where the tomatoes are lifted by mechanical elevator and deposited into a second flume for further washing and conveying. Floating trash, such as leaves and parts of vines, are skimmed off and put into bins for disposal. The field soil is allowed to settle to the bottom of the tank or flume and is periodically removed to containers for disposal. It is customary to circulate water from down-stream flumes to the flume where the tomatoes are dumped. The water in the first flume, after settling the dirt, is discharged to the disposal system.

Size Grading. Generally, in plants where tomatoes and paste products are packed, more than one dumping station is used. Loads are segregated when received and some lots are sent directly to the products line. Other lots containing canning quality tomatoes are conveyed to a size grader where undersize tomatoes are graded out and sent to the products line.

Peeling and Washing. Canning tomatoes are most frequently peeled and rinsed in a caustic peeler and washer. Waste generated here is discharged to the gutter, flumed over a screen to a bin or a hopper for disposal. The rinse water and spent lye solutions are discharged from the screen to the sewer.

Sorting. After peeling and rinsing, the tomatoes are sorted and culls removed to the gutter and to the bin or hopper. Off-color tomatoes are sorted to the products line.

Filling. The canning tomatoes are prepared in desired styles, filled into cans which are then filled with tomato juice and sealed for retorting.

Sorting (Tomatoes for Products). The whole unpeeled tomatoes are sorted and culls removed to the gutter or to the bin or hopper. The sorted tomatoes are conveyed to the chopper.

Hot Break (Tomatoes for Products). The chopped tomatoes are sent immediately to the hot break tank where they are heated and discharged to the pulper and finisher. The hot break process inactivates the pectinolytic enzymes which would otherwise cause the product quality to deteriorate.

Pulping, Finishing, Pressing. In the pulper the heated tomatoes are crushed by forcing through a perforated screen. The pulp is sent to the finisher where seeds, fiber and peel are removed and the flesh is reduced to a juice containing finely divided insoluble solids. The pomace, composed of the seeds, fiber and peel, is pressed in a screw press. The juice fraction is combined with the juice from the finisher, and the pressed pomace is sent to a dryer or collected in bins for disposal.

Juice Processing. A portion of the tomato juice may be canned as such, and the remainder concentrated for formulation into any of several tomato products.

Residuals Handling and Disposal.

The residuals from tomato processing are handled either wet or dry, some of which are discarded and others used in by-products.

Dry. Leaves, vines and trash from dumping and fluming-washing operations are usually collected in pans or similar small containers and transferred to bins. In some plants the pomace produced from pulping of tomatoes is dumped into bins. The bins of leaves, vines and trash and those containing the pomace are dumped into a truck; this waste is hauled to landfill or spread on land. In some plants the pomace is dried and bagged for sale.

Wet. The field soil washed from the tomatoes is collected in bins as mud, dumped into a truck and hauled to landfill. The cull tomatoes are sorted from the belts to flumes and gutters; the peel from the peeling operations is flushed to the gutter and, in some plants, the pomace from tomato pulping is discharged to the gutter. Material in the gutter is flumed to a sump, pumped or mechanically elevated to a screen and collected in a hopper. The hopper is periodically emptied into a truck and the residuals hauled to landfill or spread on land.

By-products. In some plants the pomace from tomato pulping is conveyed to drying equipment, dried, and bagged for use in pet food formulation.

Liquid Waste.

All food processing plants use large quantities of water to wash and transport the product, lubricate and clean equipment and to transport residual materials to on-site collection and storage facilities. For efficiency of operation and conservation of water, fresh, clean water may be used to wash the product and then be used in floor gutters to flume residual materials to on-site collection and storage.

Major sources of liquid waste include transporting product in flumes, lye peeling and rinsing, sterilizing and cooling, and evaporative product concentration.

Major sources of dissolved and suspended organic matter include product washing, transporting in flumes, and lye peeling and rinsing.

Minor sources of liquid waste include continuous or intermittent washing of belts and equipment, usually by sprays, to assure a clean efficient operation.

Liquid waste is throughly screened to remove solid material before discharge to disposal systems.

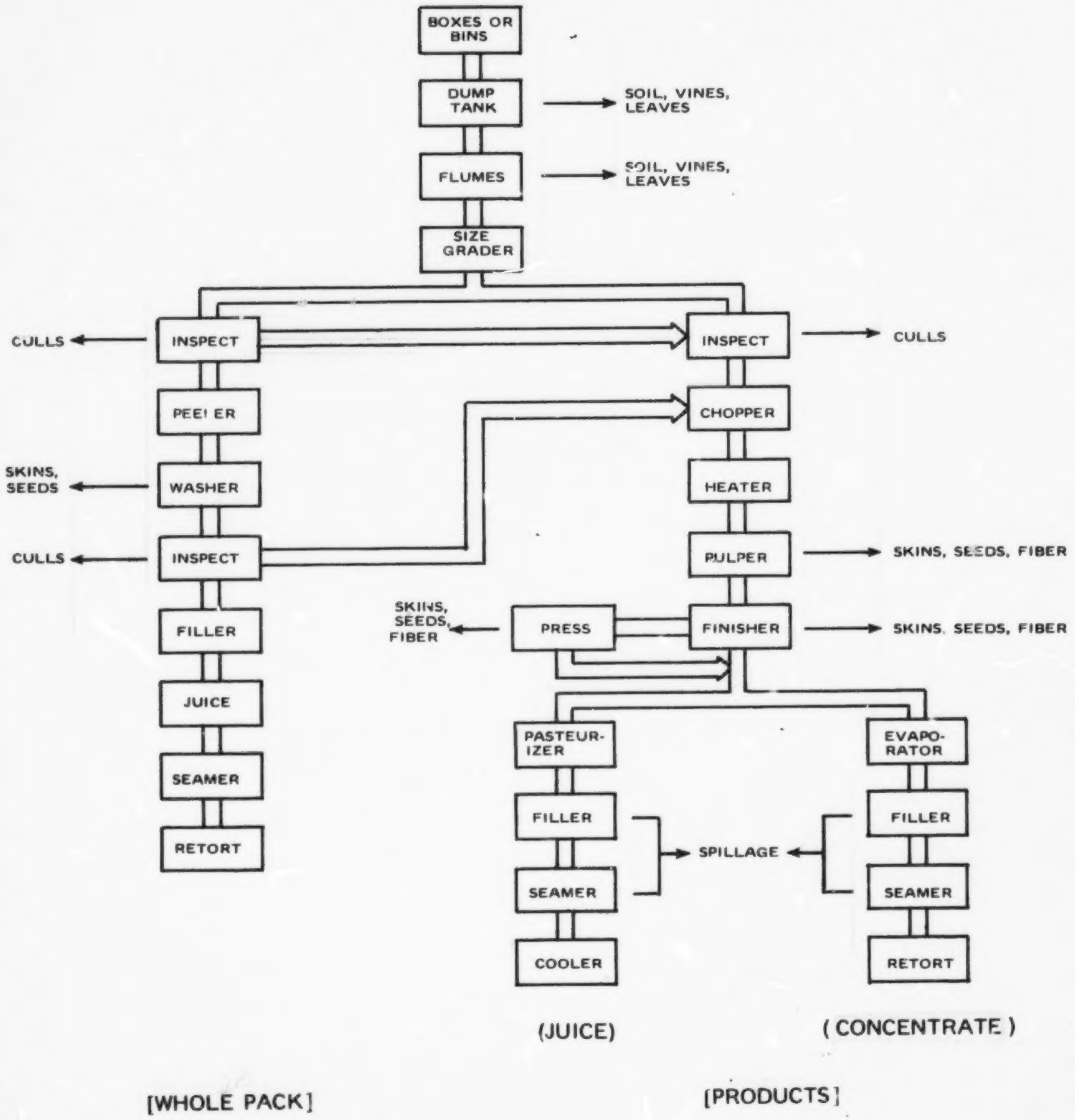
BOXES OR BINS
DUMP TANK
SOIL, VINES, LEAVES
FLUMES
SOIL, VINES, LEAVES
SIZE GRADER
CULLS
INSPECT
INSPECT
CULLS
PEELER
CHOPPER
SKINS, SEEDS
WASHER
HEATER
CULLS
INSPECT
PULPER
SKINS, SEEDS, FIBER
FILLER
SKINS, SEEDS, FIBER
PRESS
FINISHER
SKINS, SEEDS, FIBER
JUICE
PASTEUR-IZER
EVAPO-RATOR
SEAMER
FILLER
FILLER
SPILLAGE
RETORT
SEAMER
SEAMER
COOLER
RETORT
(JUICE)
(CONCENTRATE)
[WHOLE PACK]
[PRODUCTS]

Figure 14. TOMATOES -- process flow and sources of product residuals.

TABLE 25
MANAGEMENT OF TOMATO RESIDUALS
A SUMMARY OF SITE-VISIT DATA

	Waste Source				
	Fluming Washing	Sorting (Initial)	Peeling Rinsing	Sorting (Final)	Pulping Finishing
Number of Plants	35	28	25	23	31
In-plant Handling Method					
Continuous					
Dry		2		1	13
Wet	6	2	1	1	1
Wet & Dry				1	
Containers	14	6	1		1
Gutters	16	20	23	21	17
On-site Storage Facility					
Pile					
Containers	8	5			4
Elevated Hopper	12	12	14	15	15
Truck	16	9	8	6	9
Other*	4	2	3	2	3
By-product					
Feed	2	3	4	3	4
Incidental Feed	3	6	7	8	5
Other					

Number of plants surveyed: 35

*Residuals discharged with liquid waste.

Apples

Harvesting and Delivery.

Apples for processing are currently hand-harvested. Fruit is filled into bins of about one-half ton capacity or into 40-pound capacity field boxes. The apples are hauled to the cannery on trucks or trailers immediately after harvesting.

The fruit is generally processed as soon after delivery as possible. Apples which cannot be scheduled for processing within a reasonable period are placed in cold storage. If prolonged storage is deemed necessary, some apples may be placed in controlled-atmosphere storage. Apples are removed from storage as processing schedules permit.

Product Preparation. - Applesauce and Sliced Apples.

Dumping. The apples in bins or boxes are generally emptied into water to minimize bruising. Most leaves, stems and similar debris are removed in the dump tank and are discharged with the wastewater overflow or manually skimmed from the water. The apples are removed from the tank by a roller conveyor or steel-mesh belt with attached flights.

Size Grading. For maximum peeling efficiency, the apples are separated into several size categories. A few or all of the sizes may be refilled into bins and transported to appropriate processing lines or may be conveyed directly to the processing line via belt conveyors or flumes. Leaves, stems and similar material carried over from the dump tank are generally removed during the grading operation.

Peeling and Coring. Apples are most frequently mechanically peeled and cored. These operations occur within a single unit. Depending upon the make and model of peeler-corer which is used, the fruit is either manually placed on the machine or is automatically fed and positioned. The peel and core materials are discarded; the peeled fruit is generally discharged into a flume. Conveying flumes may contain a brine or sulfite solution to retard oxidation of the fruit.

In some plants peeling is accomplished with a caustic solution. To soften the skin tissue, the apples are either immersed in or sprayed with a heated caustic solution. Peel and caustic residues are removed by the use of overhead sprays. The peel material is discarded with the rinse water. If coring is desired, a separate operation is required. Apples to be cored are manually or automatically fed into the corers; the fruit is generally discharged into a flume.

Trimming. Peeled and cored apples are visually inspected while being conveyed on belts. Bruised and otherwise blemished areas are manually trimmed; the trimmings are discarded.

Slicing or Cutting. Fruit for sliced apples are manually aligned on slicing machines. Machines are used to horizontally slice each apple, thereby producing rings of approximately 1/4-inch thickness, or to vertically segment each apple into wedges.

Fruit for applesauce are automatically fed into machines and are randomly sliced or cut. Apples for sauces are frequently washed before cutting.

Generally, no residuals are removed from the slicing or cutting operation.

Washing. Fruit for sliced apples are washed after slicing; fruit for applesauce may be washed either before or after cutting. Wash tanks, reel washers, and steel-mesh belts with overhead sprays are all commonly utilized.

Residuals in the form of seeds, peel and fruit fragments are removed during the washing operation. These materials are discharged with the effluent water.

Inspection of Sliced Apples. Apple slices are deposited onto a conveyor belt where they are visually inspected prior to cooking. Large fragments, misshapen slices, and blemished or otherwise unacceptable fruit are manually removed and discarded.

Preheating. Sliced apples are heated in a steam atmosphere, often under a partial vacuum. The primary purpose of heating the slices is to remove air and gases from the tissue of the fruit, as well as to destroy enzymes. Some soluble solids are leached from the apples during steaming and are contained in the condensate which is discharged from the unit.

Cut apples for applesauce are mixed with granular or liquid sugar and passed through a thermal screw or cooker. During this heating process, the tissue of the fruit is softened and mixed with the added sugar, and the oxidizing enzymes are destroyed. No product material is lost during the operation.

Finishing. Precooked fruit from the thermal screw is passed through the finisher. The texture of the final product and the quantity of residual pomace depends upon the screen size selected by the processor. The pomace contains coarse particles, as well as seeds, stems and skin fragments which may not have been previously removed. The pomace is discarded; the finished applesauce is directed to the filler, often being first reheated by passage through a heat exchanger.

Filling. Sliced apples are manually placed into cans or glass jars, normally with the aid of circular or trough filling tables.

The containers are filled with a light syrup, passed through an exhaust box, and sealed for retorting. Spillage occurs at the filling operation.

Hot applesauce is placed into cans or glass jars by automatic fillers. The containers are immediately sealed. Glass jars are held for a few minutes and cooled by overhead sprays without further processing; cans are normally given a short cook. No product is lost during the applesauce filling operation.

Product Preparation. - Apple Juice.

Apples which have been previously separated into bins, or in some cases those apples received from the orchards, are processed into juice through the following operations.

Dumping. The apples are unloaded into dump tanks containing water or onto conveyor belts. Where dump tanks are used, the fruit is removed from the water by a roller conveyor or steel-mesh conveyor.

Crushing. Apples for juice are crushed by one of two methods. The apples may be forced through coarse screens of a pulper to produce a slurry. Leaves, some stems and some of the peel and seeds are discharged from the unit. Grinders or hammer-mills are also frequently used. In the latter case, all of the material is left in the product flow.

In plants where apples are being peeled for other styles, the peel and core materials are frequently diverted to the juice line and mixed with the product flow at this point.

Preheating. The apple particles discharged from the crusher are heated to destroy oxidizing enzymes and to soften the larger pieces. The heated slurry is then generally batch stored in tanks. During the brief storage period, filter-aid materials are blended with the slurry to facilitate subsequent extraction of the juice. Commonly used filter-aids include diatomaceous earth, rice hulls, and fiber paper. Empty paper bags in which the filter-aids were shipped are accumulated for disposal in barrels or similar containers. Some product is lost when the storage tanks are rinsed between batches.

Pressing and Filtering. Batches of the apple slurry and filter-aid mixture are layered between pieces of burlap in a hydraulic press. Pressure exerted by the press forces the juice from the mixture. The juice is collected and pumped to storage tanks; the press cake layers between the burlap pieces are removed and discarded.

Diatomaceous earth is again mixed with the juice and the mixture is clarified by passage through a cloth filter. The juice is collected; the filter cake is discarded. Empty bags are accumulated in barrels or similar containers.

Some plants use continuous presses to replace the batch pressing and filtering operation. In these situations, the intermediate storage tanks are not required. The filter cake from continuous presses is discharged from the unit in a steady flow.

Pasteurizing. The juice from the filter may be held in storage tanks or passed directly through a pasteurizer. The juice is most frequently heated to pasteurization temperatures in plate heat-exchangers. The heated juice may optionally be partially cooled prior to filling. No residuals are produced during pasteurization.

Filling. Glass bottles or cans are filled with heated juice by gravity fillers. The bottles are capped, or the cans are sealed, and the containers are cooled by overhead sprays. No further processing is required. Minimal spillage may occur around filling machines.

Residuals Handling and Disposal.

Product residuals generated during apple processing are handled both dry and wet.

Dry. Leaves, stems and similar debris accumulate in dump tanks and beneath size-grading equipment. These materials are normally collected in bins or are caught on belts and deposited into portable hoppers. The bins and/or portable hoppers are periodically emptied into waste hauling trucks for disposition by landfill or spread-and-cover technique.

Although peelings, cores and trimmings are most frequently conveyed in water, some plants utilize belt conveyors and augers to transport these materials from the processing area. Reject slices from inspection tables are often added to this residual flow. These residuals are deposited directly into water-tight dump trucks or into containers which are periodically emptied into the trucks, and are transported to vinegar manufacturers. Occasionally, some plants will divert some of these residuals to apple juice production lines, with the remainder handled as described.

Pomace from applesauce finishers and apple pulpers, as well as filter cakes from the juice press and filter, are often discharged onto drag or belt conveyors and transported to containers, permanent hoppers or directly into waste hauling trucks. These residuals have no utility and are disposed of on land.

Wet. The most common method of handling residuals from apple processing is in water. Leaves, stems and other floating debris in dump tanks are discharged into gutters. Pomace from finishers and apple pulpers, and filter cakes from juice presses and filters are also commonly discharged into the gutters. Spillages which occur at various operations are also swept and/or hosed into the floor gutters. Solids contained in the leachate from vacuum steamers and in the storage tank wash water are discharged with liquid effluent from these units. These materials are consolidated in a common sump with the wastewater and are pumped over screens. The residuals removed from the water by these screens are conveyed to permanent hoppers or directly into waste hauling trucks for land disposal. The fine solids which pass through the screens are discharged with the plant effluent.

Peelings, cores, trimmings and reject fruit are most frequently discharged into flumes. These residuals may be diverted to apple juice production lines, but are generally recovered for vinegar production. The flumes are normally combined and passed over a screen. The recovered solids are conveyed to permanent hoppers or directly discharged into water-tight dump trucks for hauling to vinegar manufacturers. The fine solids which pass through the screens are discharged with the flume water, which is consolidated with the screened plant effluent.

By-products. Peelings, cores and trimmings are handled separately from the remaining residuals for utilization in vinegar production. When the quantity of these materials exceeds the amount which the vinegar manufacturer can handle, these residuals are fed to livestock. Only infrequently is disposition of these materials required as waste.

Liquid Waste.

The major volume of wastewater from apple processing is normally generated during the washing of peeled and cored apples. Where caustic peelers are used, the rinse water following the caustic applicator makes the most significant contribution in terms of organic and hydraulic loads. Significant volumetric contributions are made by flumes which are commonly used to convey the product, as well as residuals. Although flume waters are recirculated, high overflow rates are provided to assure the maintenance of sanitary conditions within the flumes.

Minor contributions are made by dump tank overflows, equipment lubricating sprays, steam condensate from heating equipment, syrup and product spillages and the periodic rinsing of storage tanks. All but the first of these contain high concentrations of organic material and are significant in this respect.

All wastewater streams are discharged into the plant gutter system and are ultimately consolidated. The composite wastewater flow is normally screened to remove gross particulates. Fluming waters are normally screened separately prior to consolidation with the other flows. The plant effluent is then discharged into a municipal sewer system or to a company operated treatment or disposal system.

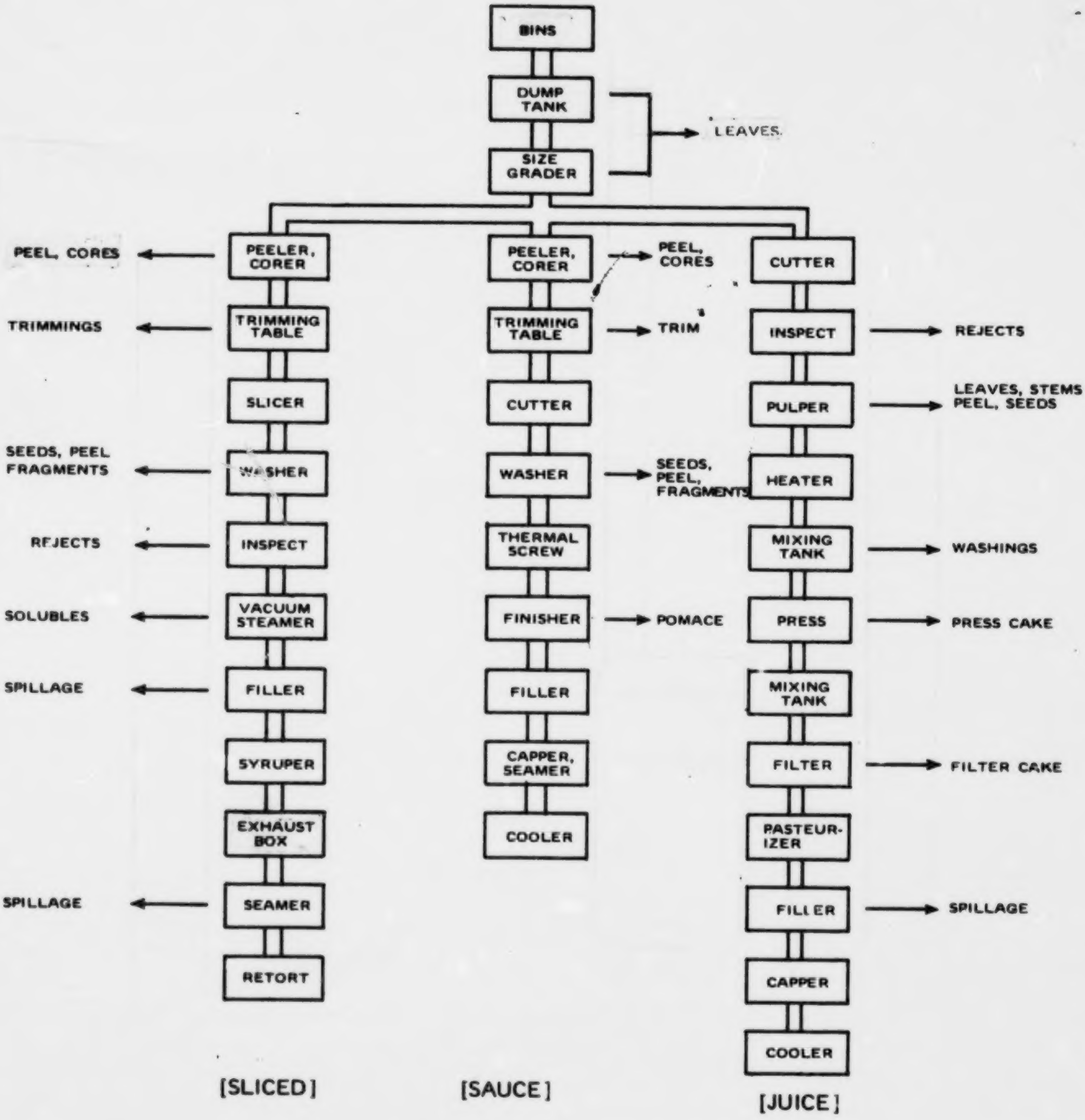
BINS
DUMP TANK
SIZE GRADER
LEAVES
PEEL, CORES
PEELER, CORER
PEELER, CORER
PEEL, CORES
CUTTER
TRIMMINGS
TRIMMING TABLE
TRIMMING TABLE
TRIM
INSPECT
REJECTS
SLICER
CUTTER
PULPER
LEAVES, STEMS PEEL, SEEDS
SEEDS, PEEL FRAGMENTS
WASHER
WASHER
SEEDS, PEEL, FRAGMENTS
HEATER
REJECTS
INSPECT
THERMAL SCREW
MIXING TANK
WASHINGS
SOLUBLES
VACUUM STEAMER
FINISHER
POMACE
PRESS
PRESS CAKE
SPILLAGE
FILLER
FILLER
MIXING TANK
SYRUPER
CAPPER, SEAMER
FILTER
FILTER CAKE
EXHAUST BOX
COOLER
PASTEURIZER
SPILLAGE
SEAMER
FILLER
SPILLAGE
RETORT
CAPPER
COOLER
[SLICED]
[SAUCE]
[JUICE]

Figure 15. APPLES -- process flow and sources of product residuals.

TABLE 26
MANAGEMENT OF APPLE RESIDUALS
A SUMMARY OF SITE-VISIT DATA

	Waste Source							
	Trash Removal	Size Grad-ing	Peeling Coring	Trim-ming	Wash-ing	Sort-ing	Pulping Finish-ing	PressSing Filtering
Number of Plants	8	3	7	6	6	6	4	4
In-plant Handling								
Method								
Continuous								
Dry	2	3	6	5		3	2	4
Wet	5					1		
Wet & Dry								
Containers								
Gutters	1		1	1	6	2	2	
On-site Storage								
Facility								
Pile								
Containers	3	1						
Elevated Hopper	2		2	2	2	2	1	2
Truck	3	2	4	3	4	4	3	2
Other								
By-product								
Feed						1		1
Incidental Feed						1	1	
Other*	1	2	5	4		2	1	

Number of plants surveyed: 8

*Apple residuals are used extensively for vinegar production.

Apricots

Harvesting and Delivery.

Apricots for processing are currently hand-harvested. Most of the fruit is filled into boxes of 40-pound capacity, but a portion, some destined for nectar or concentrate production, into half-ton capacity bins. The fruit is hauled to the cannery by truck and usually processed within a few hours. If it cannot be processed within a reasonable time, it is sent to cold storage and is returned for processing as soon as it can be rescheduled.

At delivery each box or bin usually contains fruit representing the full spectrum of maturity, from under to overmature. Modest control is exercised in the orchard during picking but the fruit must be sorted and size graded as preliminary steps to processing.

Product Preparation.

Dumping. The fruit is mechanically dumped into a tank of water to minimize bruising, and is carried by elevator to a belt where leaves, trash and cull fruit are removed to boxes and bins. Green apricots are sorted to boxes and stored at ambient temperature for 24 to 36 hours, during which time there is a significant improvement in color; they are then processed. Overripe fruit is sorted to boxes or sent by belt to processing for apricot nectar.

Size Grading. The fruit is separated into 5 or 6 sizes on the grader and returned to temporary storage in boxes or bins. Extraneous material which is not removed after dumping usually falls through the grader and is cleaned up periodically and put into bins.

The smallest size is usually processed for nectar; the next two larger sizes are canned as either the whole peeled or whole unpeeled style. The larger sizes are usually cut and packed as halves; however, the largest size may be too large for canning, in which case it is processed for nectar.

Cutting (Halves Only). Fruit to be packed as halves is cut by machine, conveyed to a perforated shaker, where the pits fall through to a flume or belt for disposal. The halves are delivered to a sorting belt.

Sorting. The halves are sorted and the cull fruit is removed to pans and dumped into bins for disposal. A quality grade separation is made on this belt with some of the fruit, such as overripe, broken or split halves being diverted to nectar. Firm halves are selected for salad stock if fruit salad is packed.

Filling. The sorted halves are conveyed to either rotary or straight-line fillers, and to further processing.

Whole Styles. The whole peeled and whole unpeeled styles are handled in much the same manner as the halves style except for processing steps peculiar to each style.

Whole Peeled Style - Peeling, Washing. After sorting to remove culls and to make a quality grade separation the fruit is conveyed to the lye peeler and then to the washer where the peel and lye solution are rinsed from the fruit. Waste generated here is either soluble or in small particles and is discharged to the gutter with the rinse water and spent lye solution.

Sorting, Filling. Sorting and filling are the same as that described for unpeeled halves.

Whole Unpeeled Style. This style may be processed alternately on the same line as the whole peeled style, merely by-passing the lye peeler-washer. After sorting to remove culls and to make a grade separation, the fruit is conveyed to the filler.

Filling. Filling is the same as that described above for other styles.

Nectar Production. The smallest sized fruit from the grader is usually diverted directly to the nectar line. Fruit from some orchards is small and may be purchased solely for nectar production. Some fruit sorted from the canning lines is processed for nectar.

Preheating. The fruit is sorted on a belt or roller conveyor to remove culls to pans and bins for disposal. It is then heated in a scroll-type heating unit with live steam to soften the flesh and free the pit. From the preheater the fruit is conveyed to the pulper and finisher.

Pulping, Finishing. In the pulper the heated fruit is crushed by forcing it through a perforated screen and the pits are removed.

The pulped fruit is sent to the finisher where the fiber and peel are removed, and the flesh is reduced to a finely divided puree. The fiber and peel are diverted to bins for disposal.

Blending. The apricot puree is pumped from the finisher to a tank where it is blended with syrup to produce nectar.

Heating, Filling. The nectar is pumped through a tubular heat exchanger where it is heated to near the boiling point and then discharged to the filler.

Concentrate. Following the pulping and finishing operations the finely divided puree may be sent to an evaporator where it is concentrated and filled into large cans or drums for shipment.

Residuals Handling and Disposal.

The residuals from apricot processing are handled either wet or dry, some of which are discarded and others used in by-products.

Dry. Leaves, trash and cull fruit from dumping, size grading and sorting, and the fiber and peel from puree preparation are usually collected in pans or boxes, transferred to metal or wooden bins, dumped into a truck and hauled to land fill or spread on land.

Wet. Some of the cull fruit and incidental residual material may be sorted or flushed to the floor gutter, flumed to a sump, pumped over a screen and the solid material collected in a hopper. The hopper is periodically emptied into a truck and the residuals hauled to land fill or spread on land.

By-products. The pits from halved apricot production are flumed or mechanically conveyed to bins, hauled by truck to a plant for conversion to by-products. Pits from production of apricot puree, having been heated, are kept separate, and are flumed or mechanically conveyed to bins or hoppers, hauled by truck to a plant for conversion to by-products. The major by-products manufactured from these pits are an abrasive cleaner from the hard outer jackets and an almond-substitute for bakery products from the soft inner germ.

Liquid Waste.

All food processing plants use large quantities of water to wash and transport the product, lubricate and clean equipment, and to transport residual materials to on-site collection and storage facilities. For efficiency of operation and conservation of water, fresh, clean water may be used to wash the product and then be used in floor gutters to flume residual materials to on-site collection and storage.

Major sources of liquid waste include transporting product in flumes, lye peeling and rinsing, sterilizing and cooling, and evaporative product concentration.

Major sources of dissolved and suspended organic matter include product washing, transporting in flumes, and lye peeling and rinsing.

Minor sources of liquid waste include continuous or intermittent washing of belts and equipment, usually by sprays, to assure a clean and efficient operation.

Liquid waste is thoroughly screened to remove solid material before discharge to disposal systems.

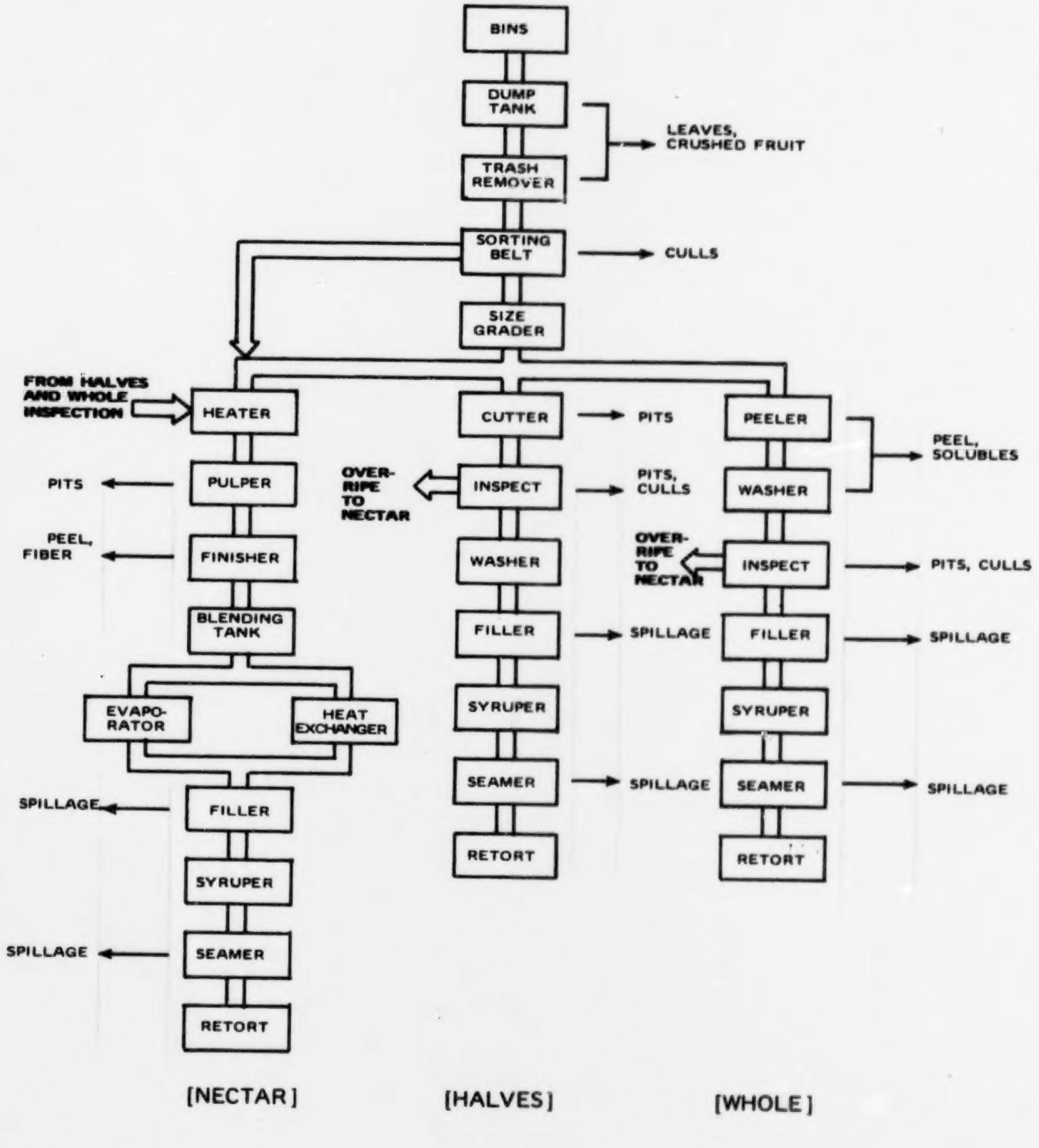
BINS
DUMP TANK
TRASH REMOVER
LEAVES, CRUSHED FRUIT
SORTING BELT
CULLS
SIZE GRADER
FROM HALVES AND WHOLE INSPECTION
HEATER
PITS
PULPER
PEEL, FIBER
FINISHER
BLENDING TANK
EVAPORATOR
HEAT EXCHANGER
SPILLAGE
FILLER
SYRUPER
SPILLAGE
SEAMER
RETORT
CUTTER
PITS
OVER-RIPE TO NECTAR
INSPECT
PITS, CULLS
WASHER
FILLER
SPILLAGE
SYRUPER
SEAMER
SPILLAGE
RETORT
PEELER
PEEL, SOLUBLES
WASHER
OVER-RIPE TO NECTAR
INSPECT
PITS, CULLS
FILLER
SPILLAGE
SYRUPER
SEAMER
SPILLAGE
RETORT
[NECTAR]
[HALVES]
[WHOLE]

Figure 16. APRICOTS -- process flow and sources of product residuals.

TABLE 27
MANAGEMENT OF APRICOT RESIDUALS
A SUMMARY OF SITE-VISIT DATA

	Waste Source						
	Trash Removal	Sorting (Initial)	Pitting	Peeling	Sorting (Final)	Pulping	Finishing
Number of Plants	7	6	7	2	7	6	5
In-plant Handling							
Method							
Continuous							
Dry	6		3			2	
Wet						2	
Wet & Dry			2				
Containers	1	4	1		2	2	3
Gutters		2	1	2	5		2
On-site Storage							
Facility							
Pile							
Containers	7	4	6		2	4	3
Elevated Hopper		2	1	2	4	2	2
Truck					1		
Other							
By-product							
Feed							
Incidental Feed							
Other*			7			5	

Number of plants surveyed: 7

*Apricot pits are manufactured into various by-products, including almond-substitute for pastries, cleaning abrasives, apricot extracts, and charcoal.

Berries

Harvesting and Delivery.

A large number of varieties are included under the term berries. In quantity, strawberries are the most significant processing variety; blueberries, red raspberries and blackberries are processed in almost equal quantities but each is well below the amount of strawberries. Other varieties worthy of note include boysenberries, black raspberries, and ollallieberries. The harvesting and processing operations for each variety are essentially identical; the same equipment is often used for several varieties since harvesting seasons are usually staggered.

Berries are hand-harvested and placed into flat wooden trays (flats). The ''caps'', consisting of the stem and sepal, are removed in the field. The flats are stacked on trucks and delivered to the processing plant. Deliveries are frequently made as seldom as once or twice a day. The delivered flats are unloaded and stacked in the receiving area at the plant; the berries are processed as quickly as possible.

Product Preparation.

Dumping. The berries are manually dumped from the flats onto a conveyor belt or directly into the washer. A minimal amount of spillage may occur during this operation.

Washing. Special oscillating washers with fine overhead sprays are commonly utilized to wash the berries. Loosely adhering caps, as well as leaves and crushed fruit fragments are removed and transported from the washer with the wastewater discharge flow. The berries leaving the washer are dewatered over bar screens.

Inspection. The washed berries are distributed in a single layer on a wide belt conveyor and are visually examined. Defective berries are manually removed and discarded; slightly crushed or discolored fruit are manually separated and accumulated in bulk containers (5-, 10-, and 25-gallon drums) for utilization in preserves or for juice.

Filling, Syruping and Sealing. Berries are manually placed into cans. The cans are then filled with syrup and sealed for retorting. Some spillage of product occurs at these operations.

Freezing and Packaging. Berries are placed on a steel-mesh belt which passes through a freezing tunnel. This process is commonly referred to as IQF (individually quick frozen). The frozen berries are discharged into a hopper which feeds automatic packaging machines. The packaged berries are placed into cardboard cases and stored for subsequent shipment. Spillage may occur at the packaging machine.

Strawberry Operations. Strawberries are normally processed in two styles. Following the washer, size graders are employed solely to separate the berries into two or three categories for diversion to the appropriate lines. No residuals are generated at this operation. Each line is provided with an inspection belt where defective fruits are manually removed.

Frozen whole strawberries are handled as described above. Strawberries for sliced style are mechanically sliced. Granular sugar or syrup is added to the strawberries in a mixing auger. The product mix is placed into containers, generally with a piston-type filler. The containers are sealed with a metal cap, placed into cases, palletized and frozen. Except for spillages which occur at the filler, no residuals are generated during the slicing, mixing and filling operations.

Residuals Handling and Disposal.

Product residuals from berry operations are normally conveyed in water. Spillages which occur at the dumping operation, and at the fillers and packagers are periodically swept and/or hosed into the gutter system. Material removed by the washer is discharged into the gutter with the wastewater flow. Defective fruit removed at the inspection belt are dropped into flumes which discharge into the gutter, or are collected in buckets or pans which are periodically dumped into a gutter.

The above residual materials are consolidated with the wastewater flows. These materials are removed from the effluent by screens and collected in containers, a hopper or in the waste hauling truck.

By-products. There is no utility for residuals from berry processing operations. The residuals are hauled from the plant and generally disposed of in landfill or spread-and-cover operations.

Liquid Waste.

The only major source of wastewater from berry processing is the washer. Fresh water is continuously utilized by this unit. The effluent from the unit is employed to convey the residuals which are discharged into the gutter system. Where flumes are utilized at inspection belts, a significant volumetric contribution to the wastewater volume is made.

The plant effluent is generally screened to remove gross particulate solids and is then discharged into a municipal sewer system or into a company-operated treatment system.

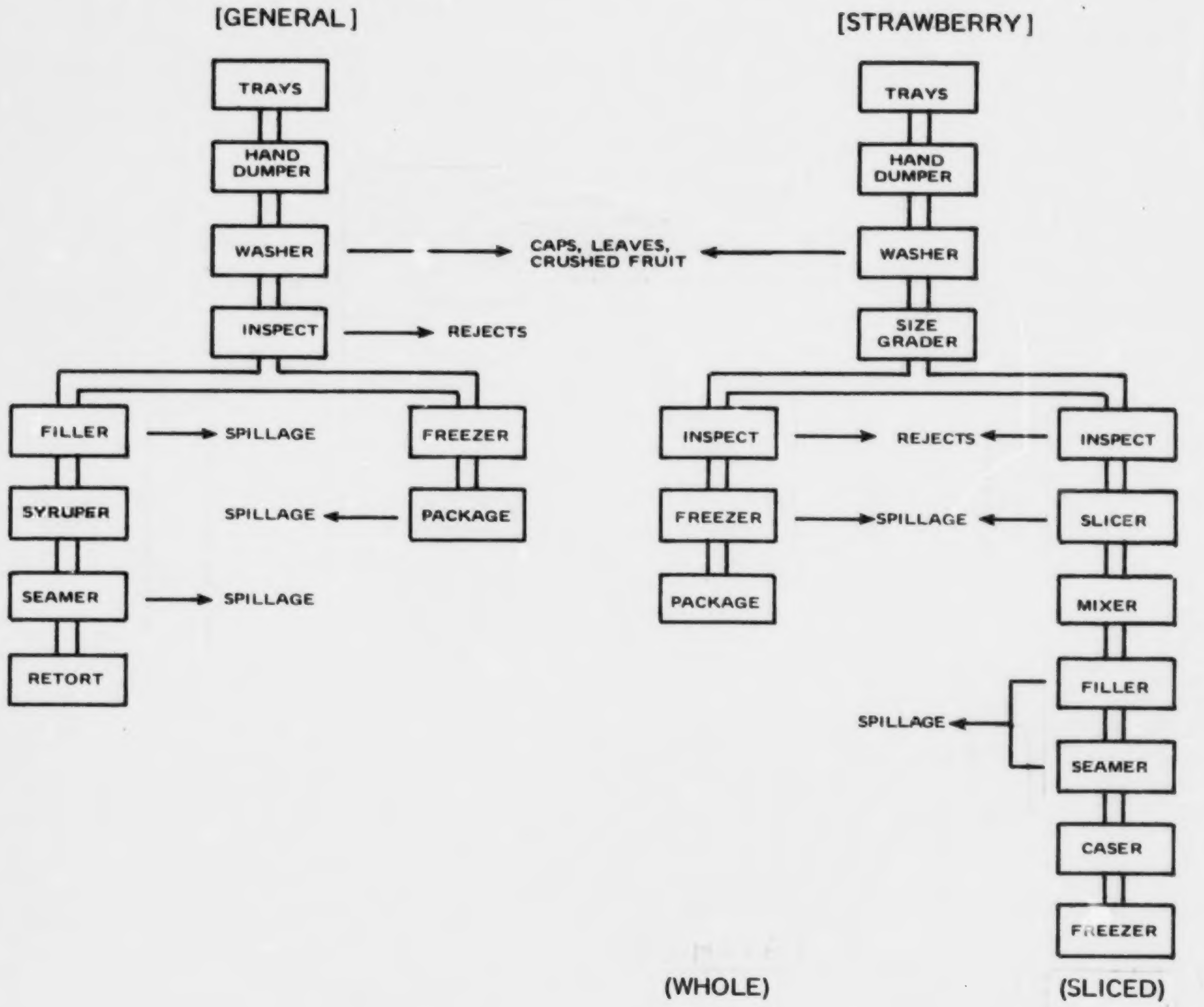
[GENERAL]
TRAYS
HAND DUMPER
WASHER
CAPS, LEAVES, CRUSHED FRUIT
INSPECT
REJECTS
FILLER
SPILLAGE
FREEZER
SYRUPER
SPILLAGE
PACKAGE
SEAMER
SPILLAGE
RETORT
[STRAWBERRY]
TRAYS
HAND DUMPER
WASHER
SIZE GRADER
INSPECT
REJECTS
INSPECT
FREEZER
SPILLAGE
SLICER
PACKAGE
MIXER
FILLER
SPILLAGE
SEAMER
CASER
FREEZER
(WHOLE)
(SLICED)

Figure 17. BERRIES -- process flow and sources of product residuals.

TABLE 28
MANAGEMENT OF BERRY RESIDUALS
A SUMMARY OF SITE-VISIT DATA

	Waste Source	
	Washing	Sorting
Number of Plants	7	7
In-plant Handling Method		
Continuous		
Dry		
Wet	1	1
Wet & Dry		
Containers		3
Gutters	6	3
On-site Storage Facility		
Pile		
Containers	2	4
Elevated Hopper	2	1
Truck	2	1
Other*	1	1
By-product		
Feed		
Incidental Feed		
Other**		2

Number of plants surveyed: 7

*Berry residuals discharged with liquid waste.
**Residuals used for preserves.

Cherries

(Red Tart Pitted and Sweet)

Several varieties of cherries are utilized for processing. Some of these are referred to as ''tart'' cherries and are normally pitted and processed primarily for use in baking. Others, such as the Royal Anne and Bing varieties, are termed ''sweet'' and are processed for direct consumption. The processing operations do not widely differ and are described together below.

Harvesting and Delivery.

Tart cherries for processing are mainly harvested by machine, whereas sweet varieties for processing are mainly hand picked. All varieties are placed into field boxes, which are stacked on flat-bed trucks, and delivered immediately to the processing plant.

The delivered boxes of cherries are unloaded from the trucks and emptied into holding tanks as quickly as practicable. Cold water is continuously added to the holding tanks and the water is recirculated. The cherries are stored in these tanks for periods of several hours. During this time, the fruit becomes turgid, thereby facilitating removal of the stone or pit.

Product Preparation.

Stemming and Debris Removal. Cherries which have attained the desired turgidity during storage are removed from the holding tanks. Normally the fruit is given a light fresh-water rinse prior to subsequent operations. The cherries are passed over stem removal equipment consisting of small, closely-spaced rollers aligned perpendicularly to the product flow. Stems, leaves and miscellaneous debris are pulled through the spaces and discharged from the unit.

Size Grading. Sweet cherries are graded into several sizes for uniformity of final product. Perforated steel cylinders and shaker tables are commonly used size grading equipment. No residuals are generated during this operation.

Color Sorting. Tart cherries are deposited on belt conveyors and visually examined for off-color fruit. These are manually removed and deposited into containers. Recently, electronic sorters have been developed and utilized for color sorting. These devices automatically reject cherries of unacceptable color and divert these to conveyors which transport the fruit from the processing area.

Washing. Cherries are given a final wash before pitting. Wash tanks, in which the water is recirculated, are normally used. A continuous flow of fresh water is provided to maintain suitable sanitary conditions within the washer and to provide an overflow to remove debris carried into the tank.

Pitting. All tart cherries are pitted; some sweet cherries are pitted, but most are canned whole. The cherries are continuously fed into the pitters which automatically align the fruit and remove the pit by boring into one end. The pits are discharged separately from the unit.

Inspection. A final visual examination is made of the cherries. Blemished or otherwise unacceptable fruit, together with pits which may not have been separated from the product, are manually removed and discarded.

Filling, Syruping and Exhausting. Both tart and sweet varieties of cherries are manually placed into cans. The cans are then filled with syrup, passed through an exhaust box to remove entrapped air, and sealed for retorting. Spillages inevitably occur at the fillers.

Freezing and Packaging. Cherries may be frozen either before or after packaging. If syrup or sugar is required, this is added to the packages of cherries prior to freezing. Sweet cherries, to which sugar is not normally added, are frozen quickly and subsequently packaged. Spillages occur during the packaging operation.

Residuals Handling and Disposal.

Although residuals from cherry processing are normally handled in water, some plants employ dry handling methods for some materials.

Dry. If so desired, all residuals from cherry processing can be handled dry. The materials most frequently so handled are the sour cherries removed at the color sorting operation. These are accumulated in bins, barrels, or similar containers for utilization in cherry juice production.

Wet. Most plants discharge all residuals into the floor gutter system. Spillages are periodically swept or hosed into gutters. These materials are consolidated in a common sump and pumped over screens. The solids which are so recovered are deposited into containers or permanent hoppers, or discharged directly into waste hauling trucks for land disposal.

By-products. Cherries which are rejected at the color sorting operation are utilized for cherry juice production. Other residuals have no utility and are disposed of in landfill or spread-and-cover operations.

Liquid Waste.

The major sources of wastewater from cherry processing are the storage tank and the washer. Where flumes are utilized to transport pits, significant volumes are added to the washer and storage tank overflows. Minor volumetric contributions are made by equipment lubricating sprays, syrup spillage, and exhaust box condensate.

All wastewater flows are consolidated and passed over screens to remove gross particulates. The screened effluent is then discharged into a municipal sewer system or to a company-operated treatment or disposal facility.

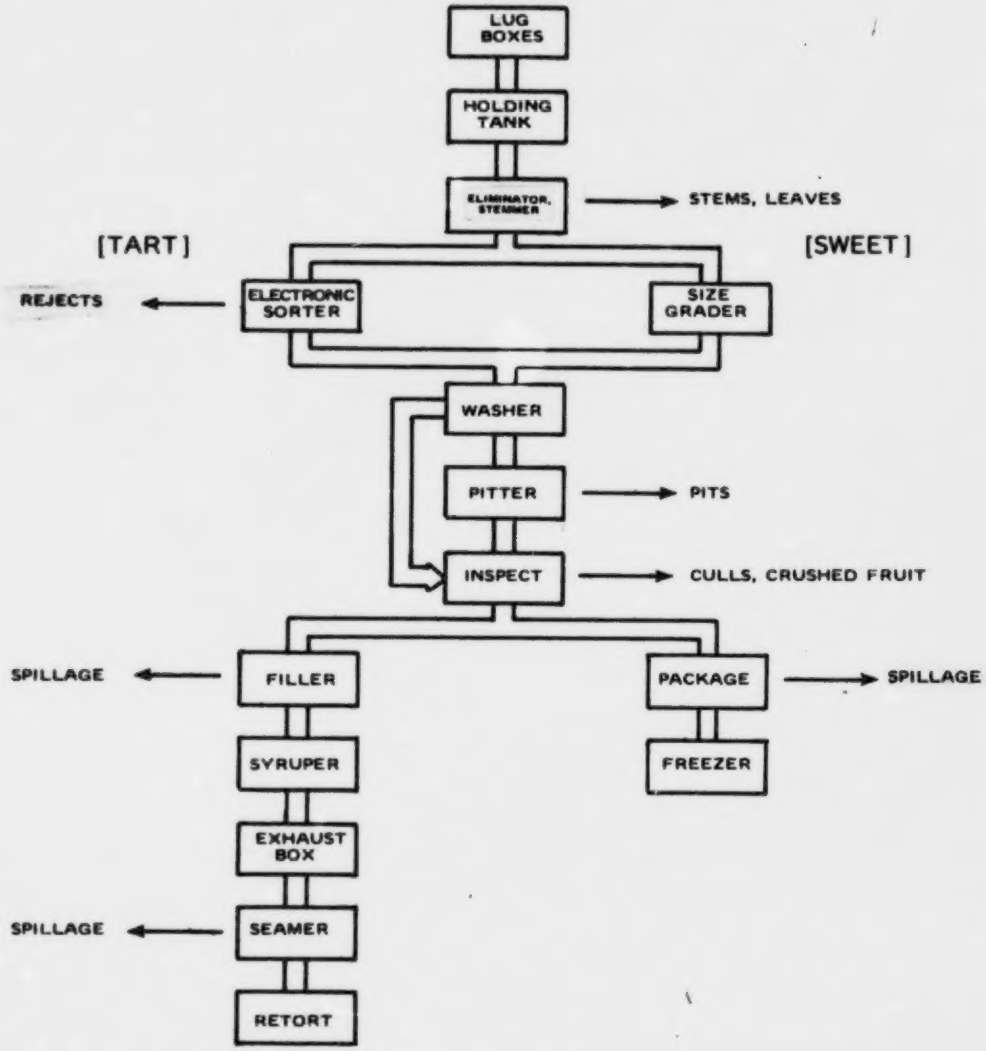
LUG BOXES
HOLDING TANK
ELIMINATOR, STEMMER
STEMS, LEAVES
[TART]
[SWEET]
REJECTS
ELECTRONIC SORTER
SIZE GRADER
WASHER
PITTER
PITS
INSPECT
CULLS, CRUSHED FRUIT
SPILLAGE
FILLER
PACKAGE
SPILLAGE
SYRUPER
FREEZER
EXHAUST BOX
SPILLAGE
SEAMER
RETORT

Figure 18. CHERRIES -- process flow and sources of product residuals.

TABLE 29
MANAGEMENT OF CHERRY RESIDUALS
A SUMMARY OF SITE-VISIT DATA

	Waste Source					
	Trash Removal	Stem-ming	Size Grading	Sorting (Initial)	Pitting	Sorting (Final)
Number of Plants	6	9	1	10	9	8
In-plant Handling Method						
Continuous						
Dry			1	1		
Wet				1	7	
Wet & Dry						
Containers	4	7		7	1	5
Gutters	2	2		2	1	3
On-site Storage Facility						
Pile						
Containers	2	2		6	1	3
Elevated Hopper	1	1	1	1	2	2
Truck	3	5		3	5	2
Other*		1			1	1
By-product						
Feed						
Incidental Feed		1		1	1	1
Other**				4		2

Number of plants surveyed: 10

*Residuals discharged with liquid waste.
**Residuals from sorting operations are used for juice production.

Citrus

Oranges account for most of the citrus production. Significant quantities of grapefruit are processed, as well as a relatively minor quantity of lemon. Other citrus fruits are insignificant. Most of the citrus crops utilized for processing are converted to single-strength and concentrated juice; the remainder is peeled and processed as fruit sections. The following discussion is limited to the description of citrus juice production.

Harvesting and Delivery.

Unlike other fruits, citrus fruits cease to mature once they have been harvested. Therefore, these fruits are hand-harvested to assure some degree of uniform maturity. Crop reports and production records list annual citrus harvests in boxes. The weight per box varies between growing regions, as well as between fruits. In actual practice citrus fruits are bulk-loaded directly into trucks or trailers, weighed, and hauled to the processing plant.

The trucks and trailers are backed onto a hydraulically-operated ramp at the processing plant. The fruits are unloaded into large receiving hoppers by elevating the front of the hauling vehicle with the hydraulic ramp. The unloaded fruit is then conveyed either directly into the processing plant, or if production schedules necessitate a delay, to large storage bins.

Product Preparation.

Initial Inspection. Generally an initial visual inspection of the fruits is made while they are being conveyed into the plant or to storage bins. Decayed, split, immature and overripe fruits are manually removed and deposited into bins or similar containers. These residuals are transported to a by-product conversion facility.

Washing. Citrus fruits must be thoroughly washed prior to processing. Flood-type washers, consisting of an immersion tank with high-pressure overhead sprays, are frequently used. Often detergent baths and/or roller-brush scrubbers, followed by spray rinses, are also used. The washing operation removes dust, leaves, stems and extraneous debris; these are discharged from the washer with the wastewater.

Final Inspection. The washed fruits are again visually inspected. Decayed, split, green and overripe fruits are manually removed and deposited into bins or similar containers. These residuals are diverted to by-products.

Size Grading. Depending upon the type of juice extracting equipment subsequently provided, the citrus may or may not require size grading. Where this operation is conducted, the fruits are mechanically divided into several sizes. No residuals are generated by size graders.

Juice Extracting. The juice is mechanically extracted from the fruit by an extractor. Although several commercially-available types of extractors are in common use, these all basically operate in a similar fashion. The pulpy juice-bearing tissues are separated from the peel, rag and seeds by cutting and squeezing. The peel, rag and seeds are collected on a conveyor or in bins and diverted for by-products; the juice and much of the pulp are collected in tanks and pumped to the finishers.

Some juice extractors simultaneously extract citrus oils from the peel. This second fluid stream is separately collected for oil recovery. The de-oiled peel, as well as the rag and seeds, is collected for by-product conversion.

Finishing. Extraneous materials are removed from the extracted juice and pulp by a finisher. The seeds and rag are completely removed. The amount of pulp which is incorporated into the juice is a function of the screen mesh size selected for use; the remaining pulp is discharged with the seeds and rag. A portion of the finished juice is drawn off, pasteurized, cooled and held for subsequent return to the product flow.

Deaerating and De-oiling. Oxygen has an adverse effect on the color, flavor, and the Vitamin C content of the citrus juice. The concentration of citrus oils in the juice also affects the quality of the product. Therefore, the entrapped air and excess oils are removed from the juice immediately following the finisher operation. Frequently, deaeration and de-oiling are accomplished continuously within a single unit. Optionally, excess oil may be removed by centrifugation, with the de-oiled juice subsequently deaerated. The oil is recovered for by-product conversion.

Pasteurizing. The pectin enzymes inherently contained in citrus fruits are inactivated by heating the juice to pasteurization temperatures in plate or tubular heat exchangers. No residuals are generated by the unit.

Evaporating. The juice is concentrated in evaporators by boiling off water under an appropriate vacuum. A series of single effect evaporators or multiple effect evaporators are commonly used for this purpose. Vapors from the evaporators are released into the atmosphere or are condensed and reused within the plant. No product loss occurs during concentrating.

Blending. To improve product quality, the concentrated juice is frequently re-combined with single strength juice. Sugar or other sweeting agents may also be optionally added. This blending is conducted in batch tanks. The tanks are thoroughly washed and rinsed between batches. Residual juice and the pulp adhering to the walls of the tanks are flushed into the gutter during the clean-up.

Filling. For canned citrus juices, single strength and concentrated juices are filled into cans while hot. The cans are then sealed, held for a short period, and water-cooled. For frozen citrus juice, single strength and concentrated juices are chilled or cooled and filled into containers. The containers are then sealed and the content quickly frozen. Minimal amounts of spillage occur around filling machines.

Residuals Handling and Disposal.

The bulk of the residuals from citrus processing is handled dry. However, minor quantities of residuals from some operations are handled in water.

Dry. Since by-products are generally recovered from citrus residuals, almost all materials are collected and handled by dry methods. Decayed, split, green and overripe fruit removed at the initial and final inspection are deposited into bins, portable hoppers or similar containers. Alternatively, these residuals may be deposited on conveyor belts and transported directly to the by-product facilities or discharged into containers for subsequent hauling.

During the extracting and finishing operations, the juice is separated from the peel, rag, seeds and pulp. The residual materials are deposited onto conveyor belts and transported directly to the by-product facilities or to large storage hoppers for subsequent hauling to those facilities.

Wet. Debris removed from the citrus product by the washers are continuously discharged with the washer overflow. These residuals are deposited into the gutters and conveyed from the processing area with the washer effluent.

Although citrus oil is not a solid residual, the oil does represent a fraction of the weight of the delivered product. The oils, which are collected at the juice extractors and/or juice de-oiling units, are pumped to a by-product recovery plant.

The remaining residuals are much like the final product itself, namely, a very dilute citrus juice containing a small quantity of pulp. These result from the periodic blending tank clean-ups, spillage at the fillers, and drippings from conveyors and other equipment. These materials are discharged directly or are periodically hosed into the gutters.

All the residuals which are conveyed from the processing area in the floor gutters are ultimately consolidated. The wastewater in which the materials are conveyed is passed over screens. The solids so removed are collected and stored in permanent hoppers for eventual disposal on land.

By-products. The primary by-products derived from citrus residuals is cattle feed. The residuals collected from the inspection belts and the juice extractors and finishers are transported to a feed production facility. Generally, such a facility is provided on-site at the large processing plants; smaller plants often haul their residuals to a nearby facility.

The accumulated whole rejected fruits, peel, rag, seeds and excess pulp are ground in a disintegrator or mill. Lime is then added to the ground residual stream and the mixture is allowed to ''age'' for a short period, generally by passage through a pug mill (large screw conveyor). The mixture is pressed to remove as much of the liquid as practicable, thereby producing a press cake and press liquor.

The press liquor is collected and preheated. The vapors emanating from the heaters are frequently condensed; the oils contained in the condensate are recovered. The heated press liquor is concentrated in vacuum evaporators, resulting in the production of crude citrus molasses. Although this molasses may be utilized for the production of sundry by-products, it is most frequently incorporated into the press cake previously produced. The vapors from the evaporators are condensed and discharged.

The press cake-molasses mixture is dried in a gas-fired dehydrator and cooled in a tumbling reel. The dried mixture may then be classified into two sizes by screens or similar separators. The coarse particles, termed the pulp, are bagged or stored for bulk shipment as livestock feed. The finer particles, termed the meal, are collected and mixed with the ''fines'' which are recovered from the dehydrator by air cyclones. The meal and fines are pelletized and bagged for use as livestock feed. However, in some operations the meal and pulp are not separated and the fines are collected for disposal on land.

In lemon processing, the peel is frequently diverted for pectin recovery. This material is treated with dilute hydrochloric acid and the resulting pectin solution is filtered out and precipitated with alcohol. The precipitate is pressed, shredded, dried, milled and bagged. The residual peel is disposed of on land.

Liquid Waste.

The major source of wastewater from citrus processing operations is the raw fruit washer. Although the water within these units is recirculated, a high fresh water replacement rate is provided to convey residuals from the washers and to maintain acceptable sanitary conditions within the units.

Minor volumetric contributions are made by spillages which occur at the juice extractors and finishers, fillers and drippings from conveyor belts. Batch blending tanks are periodically washed and rinsed. Residual juice and pulp are flushed from the tanks during these cleanups. Although the flows from these sources are small, the organic loads contained therein are appreciable.

By-product recovery facilities also contribute significantly to the plant effluent. Liquid seepage from storage areas for rejected fruits, peel, rag, and seeds contain high concentrations of dissolved organic matter. Centrifuges used to recover citrus oils discharge significant volumes of high strength waste. These streams are collected and combined with the processing wastewater.

The above waste flows are collected in floor gutters and ultimately combined. The composite flow is screened to remove particulates and is then generally discharged into company-operated disposal facilities. Commonly utilized wastewater disposal systems include spray irrigation, land flooding, and storage lagoons.

In addition to the strong wastes listed above, citrus processing includes two operations which generate significant quantities of relatively clean effluent. These are the juice concentrators in the processing plant and the molasses concentrators in the by-product plant. Vapors from these units are generally condensed, resulting in a significant quantity of water. Frequently these flows are reused within their respective plants. Excess water is usually discharged directly to a receiving stream; only infrequently is the condensate mixed with the general wastewater effluent.

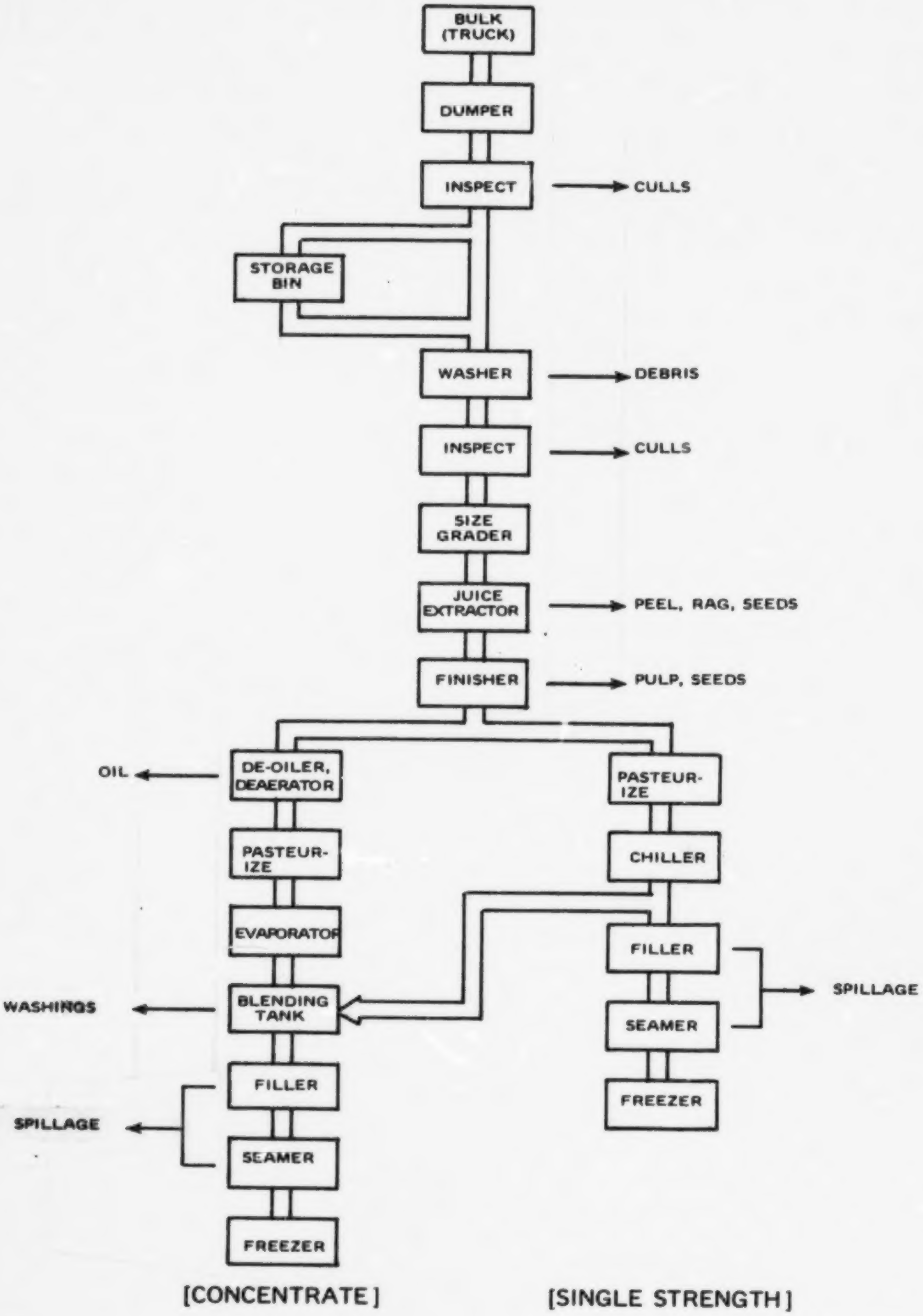
BULK (TRUCK)
DUMPER
INSPECT
CULLS
STORAGE BIN
WASHER
DEBRIS
INSPECT
CULLS
SIZE GRADER
JUICE EXTRACTOR
PEEL, RAG, SEEDS
FINISHER
PULP, SEEDS
OIL
DE-OILER, DEAERATOR
PASTEUR-IZE
EVAPORATOR
WASHINGS
BLENDING TANK
FILLER
SPILLAGE
SEAMER
FREEZER
PASTEUR-IZE
CHILLER
FILLER
SEAMER
SPILLAGE
FREEZER
[CONCENTRATE]
[SINGLE STRENGTH]

Figure 19. CITRUS (juice) -- process flow and sources of product residuals.

Cranberries

Practically all cultured cranberries are grown in the United States with Massachusetts supplying about 70% of the world's production. Cranberries are grown in low-lying cultivated bogs or marshes, which can be flooded from time to time. The flooding serves to kill off undesired vegetation prior to planting a new bog, to control insects and pests, and to prevent frost damage in early fall or late spring and damage from freezing weather in winter.

The berries generally ripen in September and October. Because of their good keeping qualities, they are the only fresh berries readily available during the autumn and early winter. Approximately half of the total harvest is processed into sauce, jelly, or juice. The rest is marketed fresh.

Harvesting and Delivery.

There are several methods of harvesting the berries. Hand picking is the oldest method, but is seldom done at the present time. In the second method, a long toothed wooden scoop is employed to comb the vines, thereby allowing the operator to remove the berries and catch them in a box-like compartment behind the teeth. A third method which is gaining in popularity, is water harvesting. The marshes are flooded so that the berries float near the surface of the water. The berries are then raked from the vines with scoops. With this method, less damage is inflicted upon the vines and fewer berries are lost through dropping than by the dry scooping technique. However, the keeping quality of water harvested berries may be adversely affected if drying is not prompt.

At the completion of the picking, the bogs are flooded so that dropped berries can be floated and gathered. These ''floats'', which are gathered with long handled rakes, sometimes account for as much as ten percent of the harvest.

The cranberries are placed into wooden bins and hauled to the processing plant by trucks and trailers. If prolonged storage is deemed desirable, the berries are cleaned and graded (as described below), replaced into bins and held in cold storage (35 to 40 F) or frozen until scheduled for canning. Storing permits a virtually year-around operation for many processors.

Product Preparation.

Cleaning. The cranberries, as received at the plant, are mixed with leaves, vines and other debris. These materials are removed by passing the berries over a shaker screen and/or through an air cleaner.

De-stoning. Stones, dirt and other heavy foreign matter, as well as lightweight materials which may have passed through the air cleaner, are water-separated from the berries in a ''de-stoner'' tank. The heavy materials accumulate on the bottom of the tank and are periodically withdrawn; the lightweight debris floats and is discharged with the overflow provided for this purpose.

Washing. The berries are subjected to a reel or flotation wash to further remove foreign matter, soluble soil, and the wax-like natural coating on the berry. The wash water temperature is controlled to discharge thawed and uniformly heated berries. Detergent is often added to the wash water to aid in cleaning and to penetrate the broken skin in damaged fruit, thereby causing it to separate out by sinking. Waste materials from the washing and subsequent fluming systems are screened out and deposited into a box or tote bin.

Inspection. The cleaned berries are passed over an inspection belt where they are visually examined. Damaged or otherwise unacceptable berries are manually removed and discarded. The cranberries are then conveyed to the appropriate production line or may be refilled into bins for storage and later processing.

Production. Cranberries are processed into one of three styles: cocktail (juices), jellied sauce, and whole sauce. The operations involved in each are outlined below.

Juice. Cranberry juice is produced by chopping the berries and pressing the resultant slurry. The juice which is recovered is strained, filtered, pasteurized and filled into bottles. After capping, the bottles are held briefly and then cooled. The press cake or pomace from the press, and the seeds, skins and stems from the strainer are discarded.

Jellied Sauce. Jellied cranberry sauce is produced by placing cleaned and sorted berries into a ‘‘popping’’ kettle. Water is added and the berries are cooked to break the skin, soften the pulp, and release the pectin. The cooked berries are then passed through a pulper which removes skins and seeds. Various size screens are used in the pulper to regulate the consistency of the sauce. The finished pulp is then transported to kettles where sugar is added and the mixture is reheated to the gel point. The blended sauce is mechanically placed into cans; the cans are then sealed, held momentarily and cooled with water.

Skins, seeds and stems are discharged from the pulpers and finishers. The cooking kettles are periodically rinsed and the sauce residues in the kettles are flushed into the floor gutters. Minimal product losses occur at fillers.

Whole Sauce. Cranberries for whole sauce are normally passed over a destemmer. The berries are then processed by the same procedure used to make jellied sauce, except that the finisher is by-passed.

Residuals Handling and Disposal.

Product residuals from cranberry processing are handled both dry and in water.

Dry. The leaves, vines, stems and other lightweight debris which are removed by the shaker screen and/or the air cleaner are collected in containers or deposited onto a conveyor belt and discharged directly into a waste hauling truck. The stones and similar heavy materials removed from the product flow by the destoner are collected in containers. The skins, seeds and stems discharged by the stemmer, the pulper and finisher, and the strainer and filter are often collected in containers. These containers are periodically emptied into a waste hauling truck.

Wet. Dirt and floatable debris are removed by the destoner and the flotation washer. These residuals are discharged into the floor gutters. Frequently, the skins, seeds and stems from the stemmer, the pulper and finisher, and the filter and strainer are also discharged into gutters. These materials are conveyed in the wastewater discharged from various units, as well as the water used to hose spillages from the floor into the gutters. These streams are ultimately consolidated and screened. The residuals removed by the screens are collected, generally in a waste hauling truck, for disposal.

By-products. There is no by-product utilization of cranberry processing residuals. All such residuals are disposed of in sanitary landfill sites.

Liquid Waste.

The major sources of wastewater from cranberry processing are the cleaning and washing operations. Destoning tanks and flotation washers are provided with a high fresh water replacement rate to eliminate floatable debris and to maintain suitable sanitary conditions within these systems. Wash water discharged during the cleaning and rinsing of batch tanks contributes significantly to the organic load, as well as the hydraulic load, of the plant effluent. Minor volumes of high strength wastes are contributed by spillages which occur at fillers.

These liquid waste streams are ultimately consolidated and screened to remove gross particulates. The screened effluent is discharged into a municipal sewer system or to a company-operated treatment or disposal facility.

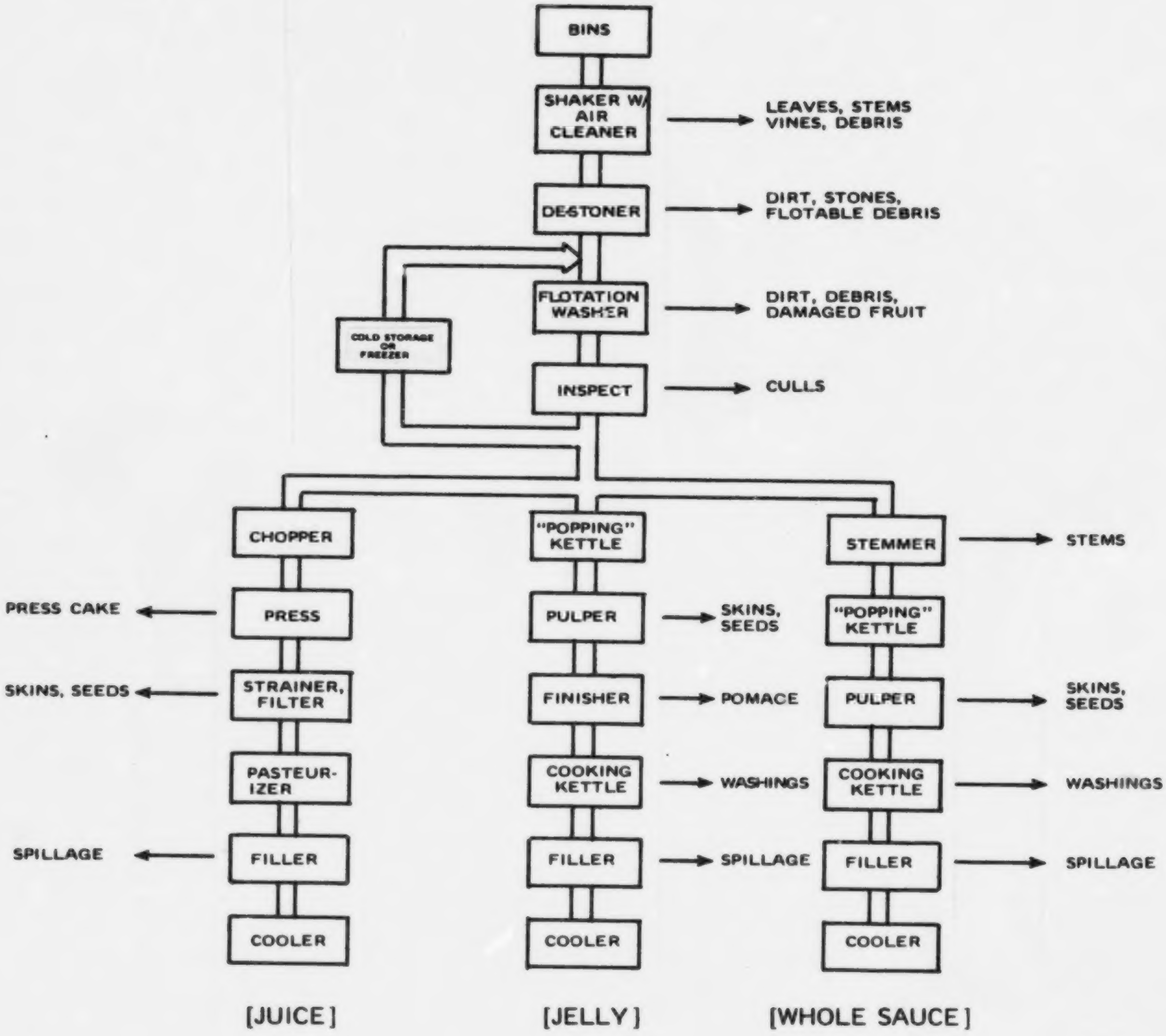
BINS
SHAKER W/ AIR CLEANER
LEAVES, STEMS VINES, DEBRIS
DESTONER
DIRT, STONES, FLOTABLE DEBRIS
FLOTATION WASHER
DIRT, DEBRIS, DAMAGED FRUIT
COLD STORAGE OR FREEZER
INSPECT
CULLS
CHOPPER
PRESS
PRESS CAKE
STRAINER, FILTER
SKINS, SEEDS
PASTEUR-IZER
FILLER
SPILLAGE
COOLER
"POPPING" KETTLE
PULPER
SKINS, SEEDS
FINISHER
POMACE
COOKING KETTLE
WASHINGS
FILLER
SPILLAGE
COOLER
STEMMER
STEMS
"POPPING" KETTLE
PULPER
SKINS, SEEDS
COOKING KETTLE
WASHINGS
FILLER
SPILLAGE
COOLER
[JUICE]
[JELLY]
[WHOLE SAUCE]

Figure 20. CRANBERRIES -- process flow and sources of product residuals.

Olives

Harvesting and Delivery

Olives for processing are currently harvested by hand; however, mechanical harvesting machines are being developed. The fruit is filled into 40-pound capacity field boxes or half-ton capacity bins. These are hauled to the cannery by truck. Since available equipment is not sufficient to handle the entire harvest at the time of delivery, the excess fruit is stored in large tanks with salt brine for later processing. Storability of olives in this manner enables the processors to extend their operations beyond the normal harvesting season.

At delivery there are leaves and twigs mixed with the olives. These are removed and the olives are then stemmed, size graded and quality sorted for subsequent processing or storage.

Product Preparation.

Dumping. The fruit is mechanically dumped to a belt and sent over a roller conveyor to eliminate leaves and trash which are collected in boxes or bins.

Stemming. The fruit is first fed to a stemmer with larger rolls to remove large stems, and then to a stemmer with small rolls where the cap stems are removed. The stems are collected in boxes and dumped into bins for disposal.

Sorting. The fruit is hand sorted to remove culls to bins for disposal. A quality grade separation is also manually conducted to remove lower grade fruit for separate processing. From the sorting belt the fruit is discharged to the size grader.

Size Grading. The fruit is mechanically separated into several sizes, and the undersize is discharged to bins for disposal. The sized fruit is delivered to dump bins for delivery to curing vats or to storage tanks.

Curing (Black Ripe). The waste generated at this step in the process is in liquid form. The fruit is cured by alternate immersion in caustic solution and in water to leach out the bitter elements, and the black ripe olives are then diverted to one of four styles: whole unpitted, whole pitted, sliced and chopped.

Size Grading, Sorting (Unpitted Style). The cured olives are again size graded to refine the sizes prior to canning. The fruit is sorted to remove culls to bins for disposal.

Pitting (Pitted Style). The cured olives are pitted; the pits with adhering flesh are conveyed to an eradicator where the flesh is removed and sent to the chopped style line; the pits are discharged to bins for disposal. Other solid waste generated during pitting is discharged to the gutter.

Size Grading, Sorting (Pitted Style). The pitted olives are size graded to refine the sizes prior to canning. The fruit is sorted to remove culls to bins for disposal.

Filling (Unpitted, Pitted Styles). The sorted fruit is conveyed to the can fillers, and to further processing.

Chopped Style. Fruit removed after pitting and some sorted out from the whole unpitted line are sent to the chopper. Waste generated here is discharged to the gutter. Chopped fruit is sent to the filler.

Sliced Style. Some of the fruit sorted out at the whole pitted line is sent to the slicer. Waste is discharged to the gutter. The sliced fruit is sent to the filler.

Filling. The prepared fruit is sent to fillers and filled into cans.

Green Pickled Style. After curing, the whole unpitted fruit is washed and sorted to remove culls to bins for disposal.

Filling. The sorted olives are filled into jars and conveyed to further processing.

Residuals Handling and Disposal.

The residuals from olive processing are handled either wet or dry, some of which are discarded and others used in by-products.

Dry. Leaves, trash and stems are collected in bins, dumped into a truck and hauled to landfill or spread on land.

Wet. Waste material from the chopper and slicer, and incidental spillage from sorting and conveying operations are flushed to the gutter, flumed to a sump, pumped over a screen and the solid material collected in a hopper. The hopper is periodically emptied into a truck and the residuals hauled to landfill or spread on land.

By-products. The undersize fruit, culls, both fresh and cured, and the pits are collected in bins, dumped into trucks and hauled to a plant for oil recovery.

Liquid Waste.

Food processing plants use large quantities of water to wash the product, lubricate and clean equipment, sterilize and cool the canned product, and to transport residual materials to on-site collection and storage facilities. For efficiency of operation and conservation of water, previously used water is used to transport residual materials.

Major sources of liquid waste include washing and curing the product, storage brines, and sterilizing and cooling.

Major sources of dissolved and suspended organic matter include storage brines, product treating solutions, and product washing and curing.

Minor sources of liquid waste include continuous or intermittent washing of belts and equipment to assure a clean and efficient operation.

Liquid wastes with lower salinity and BOD are screened or discharged to the large settling tanks before discharge to dispoal systems. Liquid wastes with high salinity and BOD are discharged to large holding ponds with impervious sides and bottoms where disposal is strictly by evaporation.

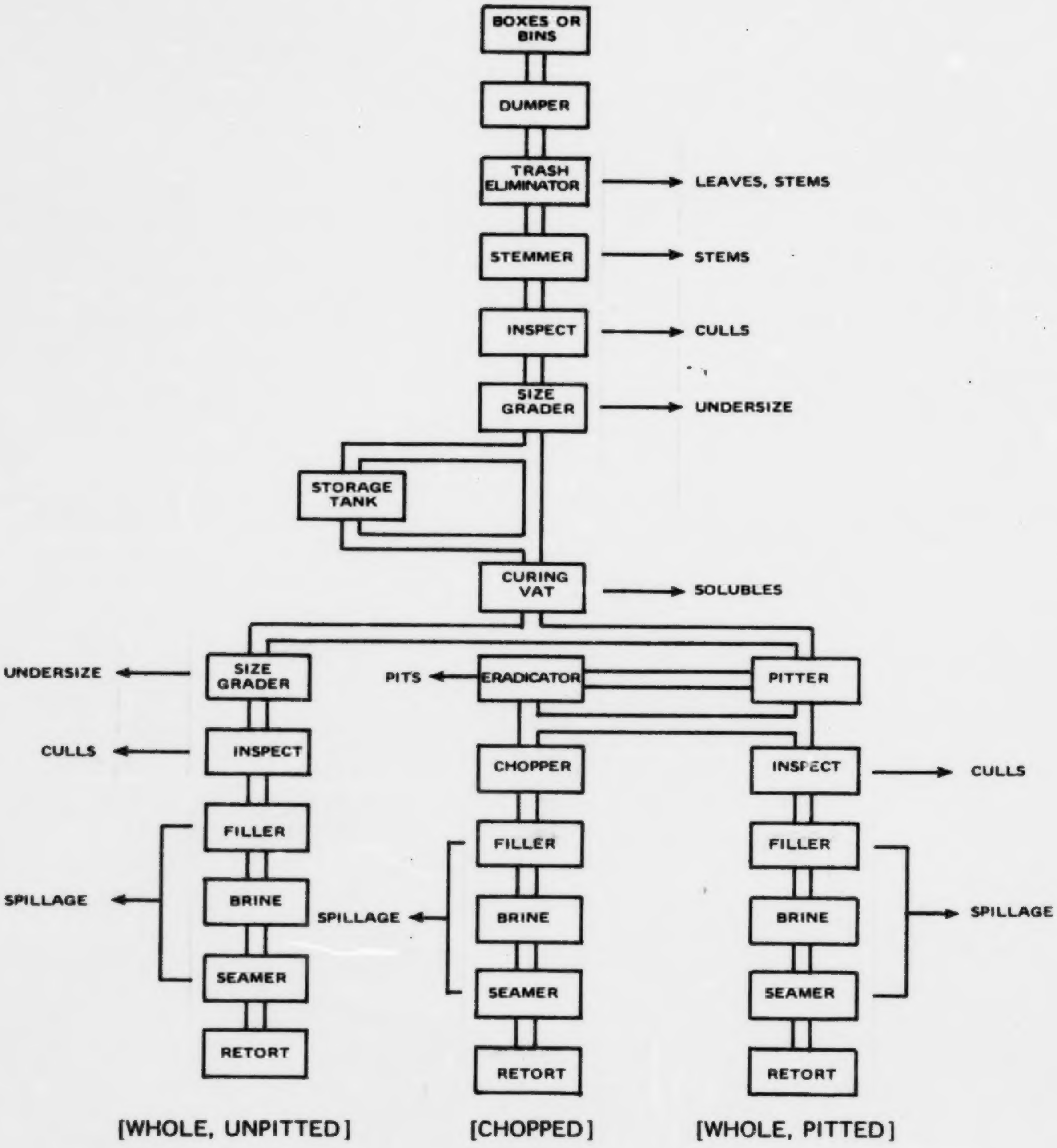
BOXES OR BINS
DUMPER
TRASH ELIMINATOR
LEAVES, STEMS
STEMMER
STEMS
INSPECT
CULLS
SIZE GRADER
UNDERSIZE
STORAGE TANK
CURING VAT
SOLUBLES
UNDERSIZE
SIZE GRADER
PITS
ERADICATOR
PITTER
CULLS
INSPECT
CHOPPER
INSPECT
CULLS
FILLER
FILLER
FILLER
SPILLAGE
BRINE
SPILLAGE
BRINE
BRINE
SPILLAGE
SEAMER
SEAMER
SEAMER
RETORT
RETORT
RETORT
[WHOLE, UNPITTED]
[CHOPPED]
[WHOLE, PITTED]

Figure 21. OLIVES -- process flow and sources of product residuals.

Cling Peaches

Harvesting and Delivery.

Cling peaches for processing are currently being hand-harvested, however, about 10% of the 1970 crop was mechanically harvested. Fruit is filled into bins of about one-half ton capacity. The bins are usually hauled by orchard truck or trailer to a centrally located receiving and grading station for transport by large truck-trailer to canneries. At the receiving and grading stations each orchard lot is sampled and a quality grade assigned, including the percent of cull fruit. If the lot fails to meet minimum grade standards the grower must sort and resubmit it for grading a second time. When a lot fails initially to meet minimum grade standards by a significant margin, the grower may, because of excessive sorting costs, elect to dispose of the lot by dumping in the orchard area.

After the lot has been passed at the grading station the canner must accept it for processing. During processing the canner must divert as waste the quantity of fruit equivalent to the percent culls determined at the receiving and grading station.

When the peaches are received at the cannery they are normally processed within a few hours. In the event fruit is received by the cannery more rapidly than it can be processed it is diverted to cold storage for processing later when it can be scheduled into the operation.

Product Preparation.

Dumping. The peaches are dumped on a belt and conveyed to a scavenger conveyor where most of the leaves and trash drop through and are collected in bins or a hopper. The fruit is then conveyed, either by water or by belt to the size grader.

Size Grading. The fruit is separated into 3 or 5 sizes on the grader, depending upon which of the two types of pitting machines are used in the plant. The smallest size is too small for processing and is collected in bins along with any extraneous material not eliminated at the dumping station.

Pitting. From the size grader the fruit is conveyed to the pitting machine where it is cut into halves and the pit is removed. The pits are conveyed mechanically or by flumes to bins or a hopper.

Sorting. The fruit is sorted on belts where the culls are diverted to pans and bins. Halves with pits are conveyed to repitting machines, and, after repitting, the fruit and pits are handled as described for the pitting operation.

Peeling, Washing. The different sizes of halves are usually recombined and conveyed to the lye peeler where they are peeled and then rinsed in the washer to remove peel and lye solution. Waste generated here is either soluble or in small particles and is discharged to the gutter with the rinse water and spent lye solution.

Sorting. After peeling and rinsing the halves are sorted and cull fruit is removed to pans and bins. The halves pass over a size grader where they are divided into 8 or more sizes and each size discharged to a sorting belt where a quality grade separation manually is made.

Slicing, Dicing. Selected sizes are sliced or diced while other sizes are canned as halves. Small fragments of fruit which are generated by slicers and dicers are removed by shaker sieves and discarded.

Filling. The fruit is conveyed to either rotary or straight-line fillers where cans are filled mechanically or manually, respectively. The cans are then filled with syrup and sealed for retorting. Product spillages occur at filling operations.

Diced peaches may be canned as such. However, it is more common to divert this style to fruit cocktail canning lines.

Residuals Handling and Disposal.

The residuals from cling peach processing are handled either wet or dry, some of which are discarded and others used in by-products.

Dry. Leaves, trash and cull fruit from dumping, size grading and sorting are usually collected in pans or boxes, transferred to metal or wooden bins, dumped into a truck and hauled to landfill, spread on land or ocean disposal.

Wet. Some of the cull fruit and incidental residual material may be sorted or flushed to the floor gutter, flumed to a sump, pumped over a screen and the solid material collected in a hopper. The hopper is periodically emptied into a truck and the residuals hauled to landfill, spread on land or ocean disposal.

By-products. The pits are flumed or mechanically conveyed to bins or hopper. The bulk of the pits are hauled by truck to a plant for conversion to charcoal. Minor quantities, from plants in outlying areas, are spread on land.

Liquid Waste.

Food processing plants use large quantitites of water to wash and transport product, lubricate and clean equipment, and to transport residual materials to on-site collection and storage facilities. For efficiency and conservation of water, fresh, clean water may be used to wash the product and then be used in floor gutters to flume residual materials to on-site collection and storage.

Major sources of liquid waste include transporting product in flumes, lye peeling and rinsing, and sterilizing and cooling.

Major sources of dissolved and suspended organic matter include product washing, transporting in flumes, and lye peeling and rinsing.

Minor sources of liquid waste include continuous or intermittent washing of belts and equipment, usually by sprays, to assure a clean and efficient operation.

Liquid waste is thoroughly screened to remove solid material before discharging to disposal systems.

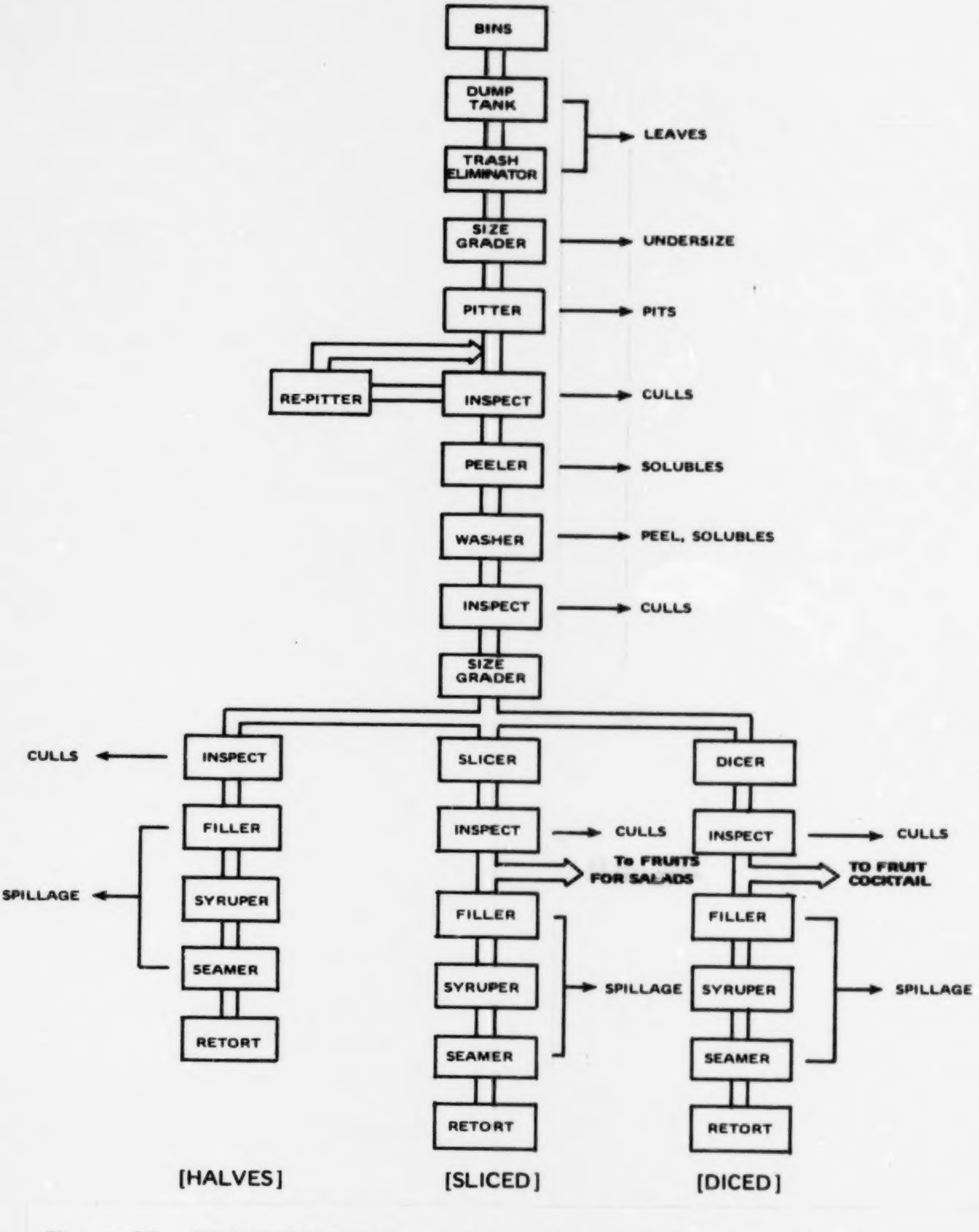
BINS
DUMP TANK
TRASH ELIMINATOR
LEAVES
SIZE GRADER
UNDERSIZE
PITTER
PITS
RE-PITTER
INSPECT
CULLS
PEELER
SOLUBLES
WASHER
PEEL, SOLUBLES
INSPECT
CULLS
SIZE GRADER
CULLS
INSPECT
FILLER
SPILLAGE
SYRUPER
SEAMER
RETORT
SLICER
INSPECT
CULLS
To FRUITS FOR SALADS
FILLER
SYRUPER
SPILLAGE
SEAMER
RETORT
DICER
INSPECT
CULLS
TO FRUIT COCKTAIL
FILLER
SYRUPER
SPILLAGE
SEAMER
RETORT
[HALVES]
[SLICED]
[DICED]

Figure 22. CLING PEACHES -- process flow and sources of product residuals.

34

TABLE 30
MANAGEMENT OF CLING PEACH RESIDUALS
A SUMMARY OF SITE-VISIT DATA

	Waste Source							
	Trash Removal	Size Grad-ing	Pit-ting	Sorting (Initial)	Peel-ing	Sorting (Final)	Trim-ming	Dicing Slicing
Number of Plants	12	12	12	12	12	12	11	11
In-plant Handling								
Method								
Continuous								
Dry	9	9	1	2		3		7
Wet		2	9				3	
Wet & Dry	1	1	3	3		1		
Containers	3			9		9		2
Gutters					12		8	2
On-site Storage								
Facility								
Pile								
Containers	11	9	1	10		12		8
Elevated Hopper	1	3	12	3	12	1	11	3
Truck								
Other								
By-product								
Feed								
Incidental Feed		1		1		1	1	1
Other			8*	2**		3**	1**	

Number of plants surveyed: 12

*Pits used for charcoal manufacture.

**Peach residuals used for alcohol production.

Pears

Harvesting and Delivery.

Pears for processing are currently hand-harvested. The fruit is filled into half-ton capacity bins or 40-pound capacity field boxes. The fruit is picked at full size and sufficiently mature to prevent shriveling as the fruit continues to ripen off the tree. Fruit from the orchard is usually held 5 to 10 days under controlled conditions to allow it to ripen properly for processing.

The pears are hauled to the cannery by truck-trailer and usually size graded while still very firm to minimize bruising. They are then stored for ripening or sent to cold storage for later processing. If sent to cold storage, the pears, after removal for processing, must be held 4 to 5 days under controlled conditions for proper ripening before processing.

Product Preparation.

Size Grading. The pears are usually dumped into water, lifted by drag or roller elevator and distributed to the size grader. The fruit is separated into 5 or 6 sizes, returned to bins or boxes and held for ripening or sent to cold storage. The leaves and trash which collect in the tank or drop through the grader are periodically cleaned up and put into bins for disposal.

Dumping. The properly ripened fruit is dumped onto a belt or into a dump tank and conveyed to peeling machines.

Peeling, Washing. Both mechanical and chemical peelers are now extensively used for peeling pears. The peel from either is very finely divided and is discharged from the machines to the gutter. Most of this material is discharged from the plant with the effluent. The stems and cores drop to a flume and gutter and are flumed over a screen to a hopper. The rinse water and spent lye solution (from the chemical peeler) are discharged into floor gutters. The pears are cut in half when stemmed and cored.

Sorting. After peeling and rinsing, the halves are sorted and trimmed, and trimmings and cores are discharged to pans and then to the gutter. A quality grade separation is made on this belt.

Other Styles. The quartered and sliced styles are prepared from halves. The cutting and sorting waste is discharged to the gutters. The diced style is usually prepared from whole peeled, stemmed and cored pears. The waste from dicing includes small pieces of fruit which are discharged to the gutter.

Filling. The fruit is conveyed to either rotary or straight-line fillers and is mechanically or manually placed into cans. The cans are filled with syrup and sealed for retorting. Product spilled at fillers is periodically swept or hosed into gutters.

Diced pears may be canned directly. However, it is more common to divert this style to fruit cocktail canning lines.

Residuals Handling and Disposal.

The residuals from pear processing are handled either wet or dry and are discarded.

Dry. Leaves, trash and cull fruit from size grading are usually collected in bins, dumped into a truck and hauled to landfill, spread on land or ocean disposal.

Wet. The waste from peeling and coring, cutting and dicing, trimming and sorting, and incidental residual material is sorted or flushed to the floor gutter, flumed to a sump, pumped over a screen and collected in a hopper. Periodically the hopper is emptied into a truck and the residuals hauled to landfill, spread on land or ocean disposal.

By-products. There is no significant by-product recovery from pear residuals.

Liquid Waste.

Food processing plants use large quantities of water to wash the product, lubricate and clean equipment, sterilize and cool the canned product, and to transport residual materials to on-site collection and storage facilities. For efficiency of operation and conservation of water, previously used water is used to transport residual materials.

Major sources of liquid waste include transporting product in flumes, lye peeling and rinsing, and sterilizing and cooling.

Major sources of dissolved and suspended organic matter include product washing, transporting in flumes, and lye peeling and rinsing.

Minor sources of liquid waste include continuous or intermittent washing of belts and equipment, usually by sprays, to assure a clean and efficient operation.

Liquid waste is thoroughly screened to remove solid material and then discharged to disposal systems.

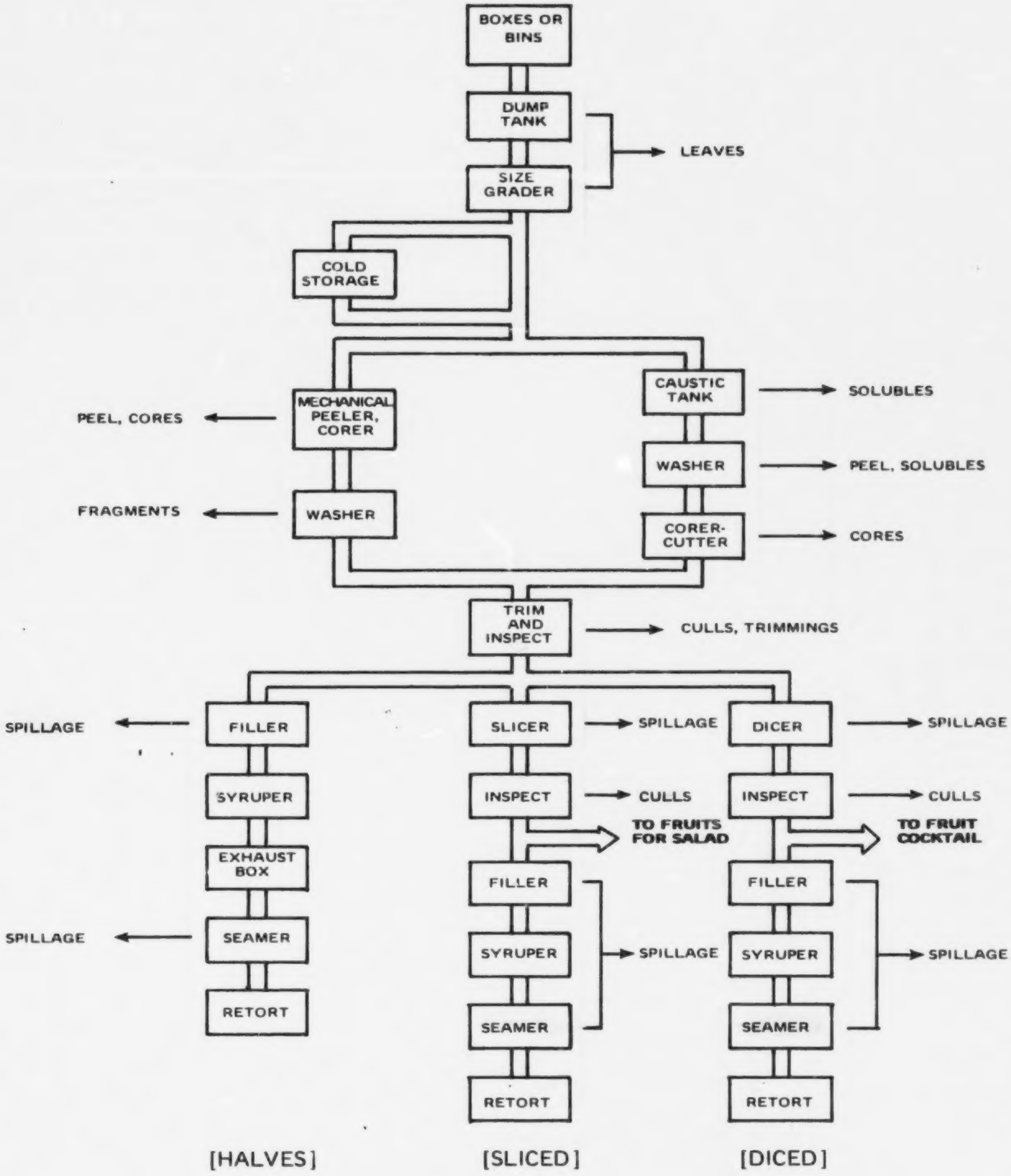
BOXES OR BINS
DUMP TANK
SIZE GRADER
LEAVES
COLD STORAGE
MECHANICAL PEELER, CORER
PEEL, CORES
WASHER
FRAGMENTS
CAUSTIC TANK
SOLUBLES
WASHER
PEEL, SOLUBLES
CORER-CUTTER
CORES
TRIM AND INSPECT
CULLS, TRIMMINGS
SPILLAGE
FILLER
SYRUPER
EXHAUST BOX
SPILLAGE
SEAMER
RETORT
SLICER
SPILLAGE
INSPECT
CULLS
TO FRUITS FOR SALAD
FILLER
SYRUPER
SEAMER
SPILLAGE
RETORT
DICER
SPILLAGE
INSPECT
CULLS
TO FRUIT COCKTAIL
FILLER
SYRUPER
SEAMER
SPILLAGE
RETORT
[HALVES]
[SLICED]
[DICED]

Figure 23. PEARS -- process flow and sources of product residuals.

TABLE 31
MANAGEMENT OF PEAR RESIDUALS
A SUMMARY OF SITE-VISIT DATA

	Waste Source				
	Trash Removal	Peeling	Sorting	Dicing Slicing	Pulping
Number of Plants	11	11	11	7	4
In-plant Handling Method					
Continuous					
Dry	5	1			
Wet	3	2	3	2	
Wet & Dry		2	1		
Containers	1				1
Gutters	2	6	7	5	3
On-site Storage Facility					
Pile					
Containers	10	1	1		1
Elevated Hopper		10	9	7	2
Truck					
Other*	1		1		1
By-product					
Feed	1	2	2	2	
Incidental Feed	1	1	1	1	
Other					

Number of plants surveyed: 11

*Residuals discharged with liquid waste.

Pineapple

Harvesting and Delivery.

Pineapples for processing are hand-harvested. Field workers follow mobile loading machines, cutting ripe fruit from the plants and placing the harvested pineapple on the conveyor belts of the loader. The fruits are loaded directly into trucks which traverse the fields with the loader. The trucks are equipped with shallow open-top beds or are loaded with large shallow bins. In the latter case, two such bins, one stacked upon the other, usually constitute a single load. The fruits are delivered to the processing plant by these trucks.

Shallow-bed trucks are generally equipped with a belt conveyor floor. These trucks unload the pineapples into large receiving hoppers or directly onto belt conveyors. Fruits received in bins normally are discharged onto belt conveyors.

Product Preparation.

Washing. Pineapples are washed by overhead sprays during transport into the processing plant. Dirt, grit and extraneous debris are washed from the fruits and discharged from the washer with the wastewater.

Inspection. The whole fruits are manually examined as they are conveyed past the inspection station. Crushed or otherwise badly damaged pineapples are manually removed from the process flow. These are diverted to the by-product recovery operations.

Size Grading. To assure minimum peeling losses, the pineapples are divided into several size categories. Identical parallel operations are subsequently provided for each category to assure uniformity of final product. Leaves and crowns which have broken loose from the fruits are mechanically removed from the process flow by the size graders.

Shelling and Coring. Specialized equipment, the Ginaca machines, are used to automatically remove the pineapple shells and the fibrous cores from each fruit. The pineapples are manually fed into the machines which automatically align each fruit in the unit. The tops and bottoms are removed and the hard outer shell is cut from the edible inner tissues. These materials are deposited onto a conveyor and transported to the milling operation.

The Ginaca machines automatically produce four fractions from the soft moisture-laden inner tissues. Beginning with the center of the fruit and going radially outward, these fractions are as follows (not described in the sequence actually produced).

1. The fibrous core is bored out of each pineapple and diverted to the juice operation.

2. A large cylinder of fruit is cut from the bulk of the inner tissue. This material serves as the basis for sliced and chunk styles of processed pineapple. The diameter of the cylinder is pre-selected according to the size of the fruit entering the machine.

3. A relatively thin layer of tissue exterior to the cylinder is cut and removed. This material is diverted to the shredders for the crushed style of processed pineapple.

4. The tissue lying just under the shell of the fruit is cut and separated from the shell. This material contains the bulk of the ‘‘eyes’’ inherent to pineapples, and is diverted with the cores to the juice operation.

Attempts are made to recover all materials generated at the Ginaca machines. However, much of the moisture released from the fruit during cutting drips onto the floors beneath the equipment. This juice, which contains particles of fruit, drains into floor gutters and is periodically flushed away by hoses.

Trimming and Inspection. The cylinders of fruit are deposited onto conveyor belts. Each cylinder is visually inspected. Remaining eyes and bruised or over-ripe segments are manually trimmed from the cylinders. Trimmings are deposited on conveyors and diverted to the juice operation. Unacceptable fragments are separately discarded and diverted to the by-product milling process. Spillages which occur around trimming tables are periodically swept or hosed into gutters.

Slicing and Inspection. The trimmed cylinders are placed on conveyors and manually fed into the slicers. A ‘‘gang’’ of knives mechanically cuts each pineapple cylinder into slices of 3/8 or 1/2-inch thickness. The slices are deposited onto the canning or filling belt. Spillages which occur at the slicers are swept or hosed into gutters.

The slices may be visually examined prior to filling. Thin and/or broken slices and fragments are manually removed, deposited on a conveyor and diverted to the chunk or crushed style lines. Over-ripe slices are removed and diverted to the juice operation. Spillages are discharged into the gutters.

Filling of Slices. Sliced pineapples are manually placed into cans. Each can is filled with pineapple of uniform color, filled with syrup and sealed for retorting. Spillages which occur at the filling table, syrupers and seamers are periodically swept or hosed into the gutter.

Dicing and Shredding, Inspection and Filling. The chunk and crushed style production operations are essentially the same; differences exist only in the size of fruit particles which are produced. Thin and broken slices and large fragments discarded from the slices line are reduced to chunks. The material from the

Ginaca machines, as well as smaller fragments from the sliced pineapple line, are passed through a shredder for crushed pineapple production. Each of these product flows are visually examined. ''Specks'' and off-colored fruit are removed and diverted to the juice or milling operation. The inspected flows are transported to the respective filling tables where the fruit is manually placed into cans. Syrup is added and the cans are sealed for retorting. Spillages which occur at each of these steps are periodically hosed into the gutter.

Juice Extraction. The outer pineapple layers removed by the Ginaca machines are combined with the trimmings and fruit particles which are diverted from inspection belts. These materials are shredded into small particles and discharged into a press. The pulp which is discharged from the press is conveyed to the by-product recovery operation.

The extracted juice is heated and passed through a centrifuge to remove the heavier solids. The discarded solids are either discharged into the gutter system or collected and diverted to the by-product recovery operation. The extracted juice is filled into cans which are then sealed for retorting. Spillages which occur at the various extraction and filling steps are washed into the gutter system.

Residuals Handling and Disposal.

Product residuals from pineapple processing are handled both dry and in water.

Dry. Since most of the product residuals from the pineapple processing is generally recovered for by-product conversion, the residuals are handled by belt or other ''dry'' conveyors. Materials so handled include reject whole fruit from the initial inspection, the pineapple crowns and bottoms, as well as the shells, from the Ginaca machines, unacceptable trimmings and fruit fragments removed from the processing lines, and the pulp discharged from the juice extracting press.

Wet. Product residuals are frequently discharged into the floor gutter system at various points within the processing plant. These include debris removed at the washer, solids discarded at the juice centrifuge, as well as product and juice spillages which occur at numerous points along the process flow. These materials are conveyed in the wastewater flows discharged from various operating units and in the water used to periodically flush spillages from the floor into the gutter system. These residuals are combined, generally in a common sump, and pumped over screens. The solids removed by the screens are collected and diverted to by-product recovery operations, or are disposed of on land.

By-products. By-product recovery facilities are generally, although not universally, provided. Where such operations are not conducted, the residuals described below must be disposed of, most commonly by landfill.

The materials which are normally handled dry, as described above, are consolidated, frequently with the material recovered at the wastewater screens, and passed through shredders or mills. The milled particles are pressed to extract the fruit juices. The pulp from the mill is mixed with molasses which is recovered from the press juice, dried and bagged for use as cattle feed.

The mill juice, or press liquor, is heated and filtered, often with the use of a filtering aid such as diatomaceous earth. The filter cake which is removed is collected and disposed of by landfill. The filtrate is converted into one or more of several by-products. These include alcohol or vinegar through fermentation, molasses through concentration, syrup through ion-exchange purification, or sugar through evaporation. Molasses produced from the mill juice is blended with the pulp for animal feed; syrup produced for purification by the mill juice is frequently used as the filling liquid for canned pineapple.

Liquid Waste.

The largest volume of wastewater from pineapple processing is generated by the washers. This wastewater flow contains dirt, grit, leaves and miscellaneous debris, the bulk of which is removed by screening. The washer effluent contains very low concentrations of dissolved organic material. Therefore, this effluent stream is often separately discharged after screening, usually with the can cooling water.

Major sources of dissolved and suspended organic matter, as well as significant volumetric contributors, include the Ginaca machines, the trimming tables, and the slicers. Fruit juices are continuously discharged with the lubricating spray used at each of these units. Fruit juice lost from the juice extracting equipment, especially the juice centrifuge discharge, as well as juices and product spilled onto floors at various operations, contribute significantly to the organic load of the process wastewaters.

Operations for recovering by-products from the mill juice contribute significantly to the organic load. Filter cakes are oten discharged with the wastewater, the sediment in alcohol or vinegar fermentation tanks is drained into the gutter system, and the regenerant and rinse solutions from ion-exchange columns are added to the general plant effluent.

All of the processes and by-product wastewaters are consolidated and screened to remove gross particulates. Since the composite wastewater flow is quite acidic, lime is normally added to the screened effluent in sufficient quantity to neutralize the fruit acids and to attain a slightly alkaline pH. The neutralized flow is then generally discharged into a municipal sewer system.

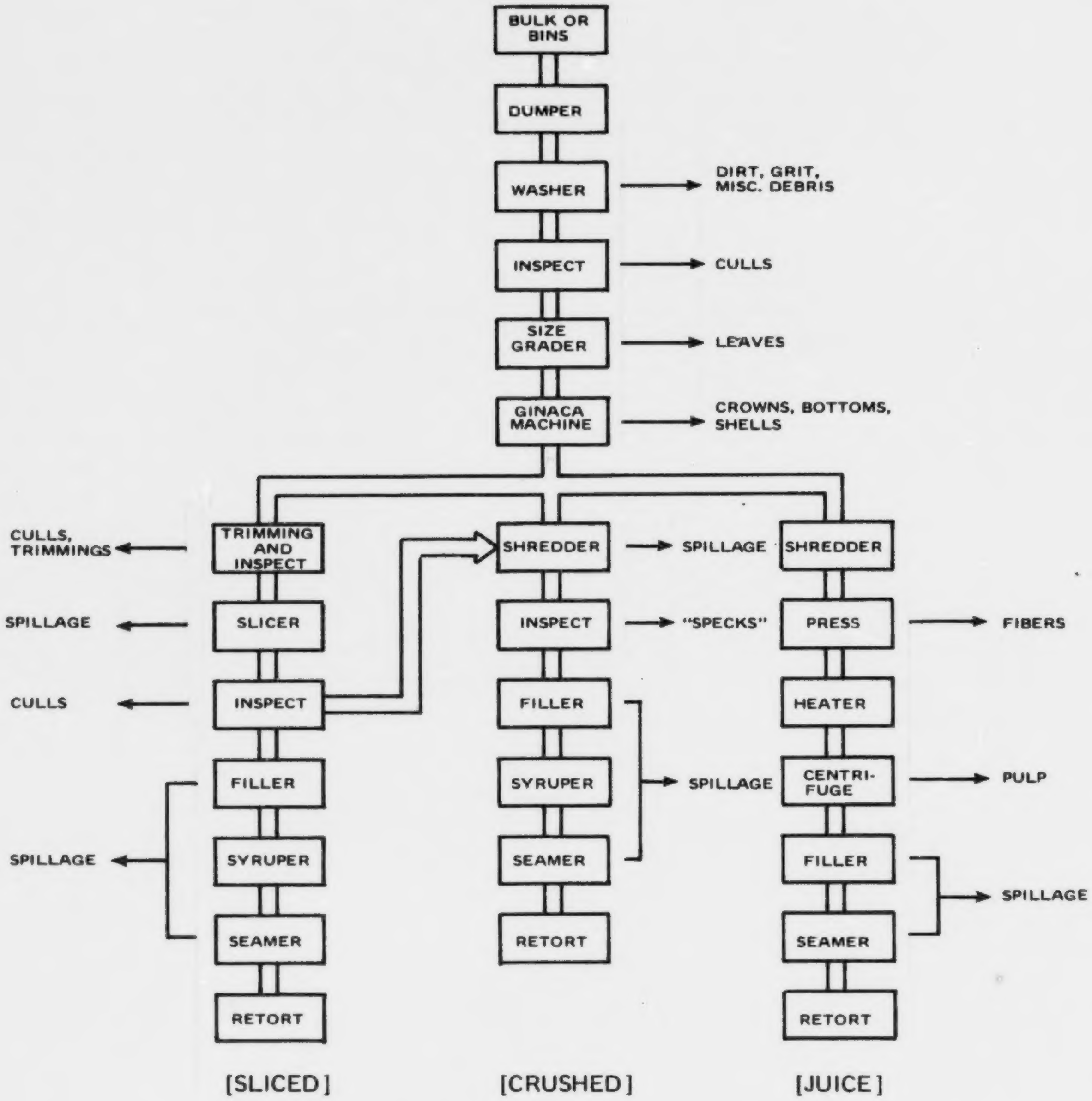
BULK OR BINS
DUMPER
WASHER
DIRT, GRIT, MISC. DEBRIS
INSPECT
CULLS
SIZE GRADER
LEAVES
GINACA MACHINE
CROWNS, BOTTOMS, SHELLS
CULLS, TRIMMINGS
TRIMMING AND INSPECT
SHREDDER
SPILLAGE
SHREDDER
SPILLAGE
SLICER
INSPECT
"SPECKS"
PRESS
FIBERS
CULLS
INSPECT
FILLER
HEATER
FILLER
SYRUPER
SPILLAGE
CENTRI-FUGE
PULP
SPILLAGE
SYRUPER
SEAMER
FILLER
SPILLAGE
SEAMER
RETORT
SEAMER
RETORT
RETORT
[SLICED]
[CRUSHED]
[JUICE]

Figure 24. PINEAPPLE -- process flow and sources of product residuals.

Salmon

Harvest and Delivery.

The time and duration of the salmon canning season is entirely dependent on natural conditions. The fish are caught by trolling or more commonly by gill nets or purse seines. They are either delivered directly to the cannery or to tenders or scows which then deliver to the cannery.

The whole salmon are unloaded into a bucket elevator at the cannery dock. They are transported either into storage bins or into refrigerated brine tanks depending on whether they are to be processed immediately or held for a short period before processing. In this area the fish are moved either by rubber belts or salt water flumes. Through the remainder of the processing operation they are moved by rubber belts or in some operations by hand carts.

Product Preparation.

Butchering. From the holding bins the fish are transported to the header and automatic eviscerating machine commonly called the iron chink. The fish are manually placed on the machine which removes the head, tail, fins and viscera from each salmon.

Cleaning. After removal of the heads, tails, fins and viscera the salmon proceed to the sliming table where they are inspected and any remaining pieces of viscera or fin are manually removed. The cleaned salmon are then transported to filler holding bins.

Filling. Most salmon canneries use automatic filling machines, except for the 4 pound or institutional can size which is hand packed. The salmon are placed on a timed chain and are automatically cut to size and forced into the cans. Pieces of fish inadvertently accumulate beneath the fillers. These materials are periodically swept or hosed into the gutters. Because of high shipping costs to the remote areas in which most salmon canneries are located, cans are received flattened with no ends attached. These flattened can bodies are reformed, flanged and the bottom end attached in the can reforming area. They are then carried to the filler by gravity or cable runways.

Weighing and Seaming. From the filler the cans pass through a weighing machine which side tracks underweight cans. All cans including the underweights then pass over the patching table where they are visually inspected and check weighed. Excess salmon is removed from obvious overweight cans and small pieces or patches are added to bring the underweight cans to the desired weight.

From the patching table, the cans proceed to the clincher where the lids are loosely attached. The double seam is then completed in a closing machine under mechanical vacuum and the cans are processed.

Pieces of fish, some of which is finely ground, accumulate around patching tables and seamers. These residuals are periodically hosed into the gutters.

Residuals Handling and Disposal.

Although residuals from salmon processing are generally handled in water, certain materials are frequently handled dry.

Dry. The fish heads are often rendered for oil recovery. Oil so recovered is added to the canned product. The heads are separately collected in containers for transport to the rendering facility. The residuals from the rendering plant are disposed of with the general product residuals.

Frequently, eggs are separated from the viscera. These are collected in containers, cleaned of debris, and packed with salt for preservation as human food.

Wet. Residuals from the butchering area, consisting of heads, tails, fins and viscera, are generally deposited into flumes or gutters and hydraulically conveyed from the processing area. Pieces of fish which tend to accumulate on the floor beneath the fillers, patching tables, and seamers are periodically swept or hosed into gutters. These materials are consolidated, generally in a central gutter, and removed from the water by screening.

Where economically feasible, product residuals which are recovered by screens are converted to fertilizer or animal feed. Materials so utilized are collected in waste hauling trucks. In remote areas screened residuals are collected in barges and hauled to sea. In isolated regions the residuals are often ground and discharged directly to tidal waters.

By-products. Because of the remote locations in which most salmon canneries are situated, utilization of product residuals is deemed uneconomical. However, some canners grind and render the fish heads for oil to be added to the canned product. In many cases eggs are collected and preserved for use as human food or bait. In a few situations, product residuals are converted to fertilizer or animal food.

Liquid Waste.

In plants where delivered fish are flumed and/or refrigerated, the largest volume of wastewater is generated by the flumes and refrigeration tanks. However, sea water is used in these operations, during which time the characteristics of the water are not significantly altered. These flows are generally discharged directly to tidal waters.

The largest volume of processing wastewater is from the rinse sprays provided at the end of the iron chink. This flow, augmented by water used to flush the gutters, is used to convey product residuals deposited into the gutter system. Hoses used to clean the floors and equipment add significantly to the plant effluent. These streams are consolidated, generally in a central gutter, screened to remove solids, and discharged from the plant.

Processing wastewaters are discharged into municipal sewer systems when the cannery is located in an urban area. More frequently, however, salmon canneries are located in remote areas. In the latter case, the screened effluent is discharged into tidal waters, either directly or through a submerged outfall.

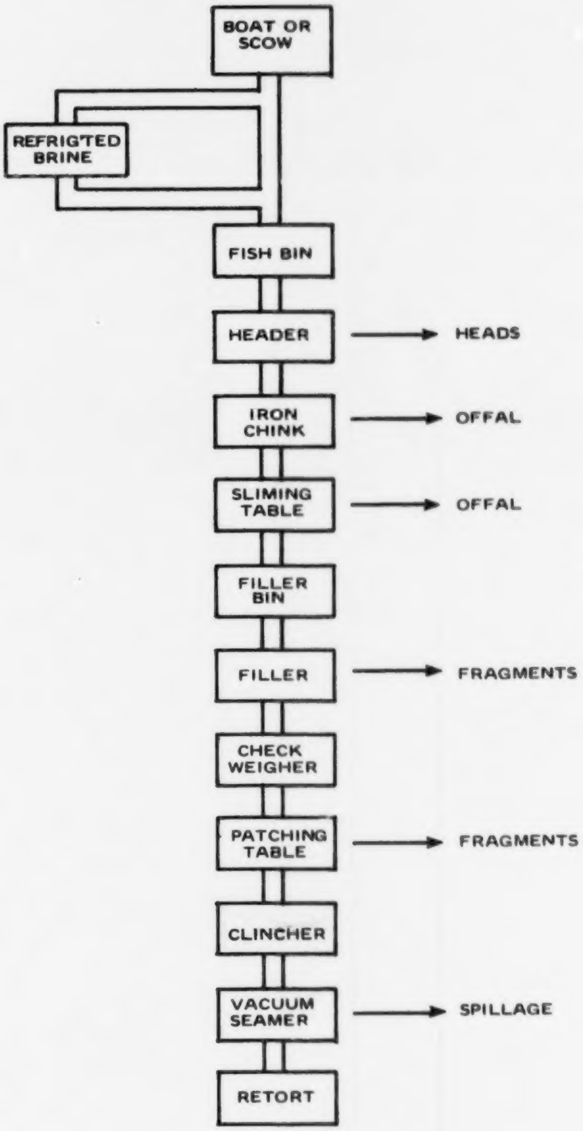
BOAT OR SCOW
REFRIGTED BRINE
FISH BIN
HEADER
HEADS
IRON CHINK
OFFAL
SLIMING TABLE
OFFAL
FILLER BIN
FILLER
FRAGMENTS
CHECK WEIGHER
PATCHING TABLE
FRAGMENTS
CLINCHER
VACUUM SEAMER
SPILLAGE
RETORT

Figure 25. SALMON -- process flow and sources of product residuals.

Sardine

Harvesting and Delivery.

Sardines are caught in purse seines or weirs. They are kept alive for a sufficient length of time to permit their digestive tracts to become free of food material. The fish are then hauled aboard the boat and salted. Salting acts as a preservative in the event a long haul is necessary, and it initiates the pickling process.

When the boats arrive at the factory the fish are inspected by a state inspector. Sea water is then pumped into the holds and the fish are pumped to pickling tanks in the factory. The pumping system water is screened to remove the fish scales which are abraded from the sardines.

Product Preparation.

Brine Soaking. The sardines are removed from the flume by screens and placed into pickling tanks. If salt has not been added previously in the boat, it is added to the pickling tanks. The fish are held in the tanks, generally with mechanical agitation, for several hours. If processing schedules necessitate a delay of 24 or more hours, the brine solution is refrigerated. The salt acts as a seasoning and a preservative, while increasing the firmness of the flesh.

Trimming and Culling. The fish are removed from the pickling tank and conveyed to trimming tables. Species other than sardines are manually removed and diverted to by-products. The heads are manually cut from the small sardines; both the head and tail are removed from the larger fish. The offal is collected and diverted to by-products.

Filling. The sardines are manually placed into cans. Large fish are trimmed to size; the trimmings are diverted to by-products. The packed cans are placed on trays, which in turn are loaded on racks or carts.

Precooking and Cooling. The racks of packed cans are wheeled into a steam room or steam chamber in which the fish are cooked. Frequently the trays of packed cans are dipped into a brine solution prior to steaming. After the sardines have been steamed for approximately 20 minutes, the cans are inverted for draining and cooling. The brine and steam condensate, together with fish oils which are leached from the sardines, are collected in floor gutters and discharged with the plant effluent.

Saucing and Seaming. After cooling, the cans are placed on a conveyor and transported to the saucing operation. Oil and/or formulated sauce is added to each can. The cans are then sealed and washed prior to retorting. A minimal quantity of product is lost due to spillage at the saucing and seaming operations.

Residuals Handling and Disposal.

Residuals from sardine processing are generally handled in water. However, some materials are handled dry in a few plants.

Dry. Cull and rejected fish, heads and tails from the culling and trimming tables are deposited onto a drag conveyor. These materials are discharged directly into waste hauling trucks. These residuals are, however, more frequently conveyed hydraulically.

Wet. Fish scales which are abraded from the sardines during pumping are removed from the water by screens. This residual material is normally collected in containers for by-product utility.

Rejected fish and offal from the trimming tables are normally deposited into flumes and conveyed from the processing area. These residuals are removed from the water by screens and collected in waste hauling trucks for by-product conversion.

Product spilled onto floors are periodically hosed into the gutters. Such materials are removed from the plant effluent by screens and collected in waste hauling trucks for land disposal or by-product conversion.

By-products. Fish scales which are removed from the pumping system are used for the manufacture of cosmetics and buttons. Rejected fish and offal are transported to fish meal plants for processing into pet foods. Residuals recovered from the plant wastewater effluent may also be diverted to a fish meal plant, but more frequently, these materials are disposed of.

Liquid Waste.

The major sources of wastewater from sardine processing are the delivery pumping system and pickling tanks. Fish scales are the only residuals contained in these streams. This material is removed by screens and the wastewater is discharged into the ocean or bay.

A significant quantity of processing wastewater is generated to hydraulically convey residuals. Flumes and gutters are continuously flushed, generally with sea water, to remove residuals from the processing areas. Condensate and fish oils from the steam rooms are added to the effluent. The flows are ultimately combined, screened to remove particulates, and generally discharged directly to receiving water.

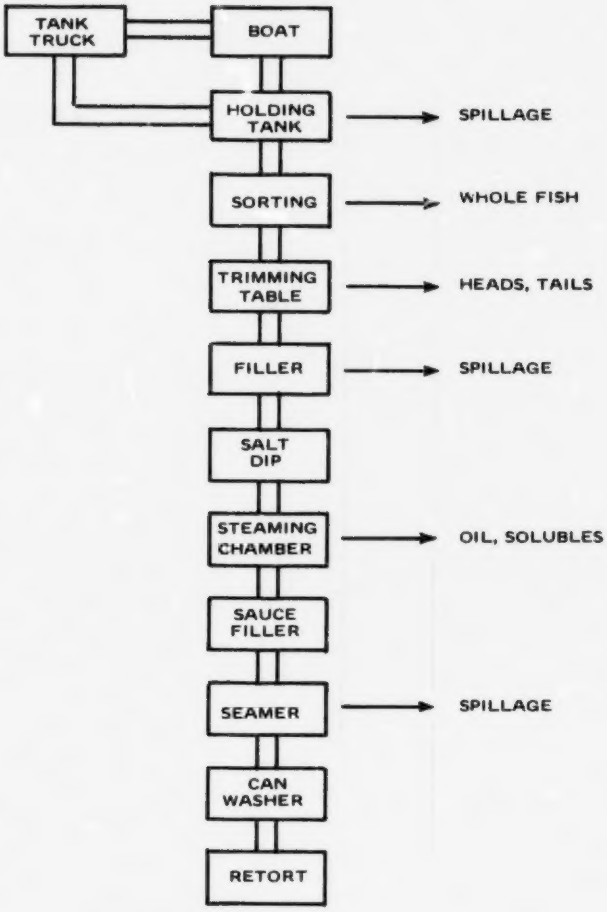
TANK TRUCK
BOAT
HOLDING TANK
SPILLAGE
SORTING
WHOLE FISH
TRIMMING TABLE
HEADS, TAILS
FILLER
SPILLAGE
SALT DIP
STEAMING CHAMBER
OIL, SOLUBLES
SAUCE FILLER
SEAMER
SPILLAGE
CAN WASHER
RETORT

Figure 26. SARDINE -- process flow and sources of product residuals.

Shrimp

Harvesting and Delivery.

The common shrimp (Panaeus setiferus) also called white shrimp comprises the majority of the total catch. The greater part of the catch is taken along the Gulf Coast with Louisiana accounting for more than 65%.

Shrimp are caught with otter trawls, haul seines, and nets. Otter trawls are most frequently used due to their simplicity of handling. The shrimp are sorted and iced aboard the individual boats. The shrimp may be held aboard in ice for 1 to 5 days until delivery to the cannery. At the wharves generally adjacent to the cannery, the shrimp are either shoveled onto conveyors or into wire baskets and then discharged into a tank filled with running water. Some shrimp are hauled to the cannery aboard trucks, then shoveled into the tank.

Product Preparation.

Initial Inspection. The shrimp are removed from the water tanks with inclined conveyors and are transported to an inspection table. Unacceptable shrimp and other fish are manually removed and deposited into baskets or lug boxes. The acceptable shrimp are automatically weighed and transported to the peeling machines by conveyor belt or in tote bins.

Peeling and Cleaning. Shrimp are almost exclusively peeled automatically. The shells are removed from the shrimp and generally deposited into a flume. The peeled shrimp are discharged into a fresh water flume and conveyed to a cleaning machine. Shell fragments and extraneous debris are washed from the shrimp and discharged into the gutter with the wastewater. The cleaned shrimp are visually examined; unacceptable shrimp and miscellaneous materials are manually removed.

Deveining and Washing. The veins, or digestive tracts, are mechanically removed. The residuals are discharged into the floor gutter. The shrimp are thoroughly washed and allowed to drain on a steel-mesh conveyor.

Blanching. The drained shrimp are then blanched for 5 to 7 minutes in open vats containing boiling salt brine. Blanching gives the shrimp their characteristic pink color and also causes them to curl.

Size Grading and Final Inspection. Mechanical vibrating graders are used to grade the shrimp into various sizes. After being graded the shrimp are inspected to remove any odd sizes, pieces, or extraneous material. Residual materials are generally deposited into the floor gutter.

Filling. The shrimp are placed into cans manually or by machine. Salt brine is added to the ‘‘wet pack’’ style, the predominant form in which shrimp are canned. No brine is added to the so-called ''dry pack'' style. The filled cans are sealed under vacuum and retorted. Spilled product which tends to accumulate around fillers is periodically hosed into the gutter.

Residuals Handling and Disposal.

Product residuals from shrimp processing are handled both dry and in water.

Dry. Rejected shrimp and fish of various other species which are removed at the initial inspection are generally deposited into baskets or lug boxes. These containers are in turn emptied into waste handling trucks which transport the residuals to a land disposal site.

Wet. Shrimp shells from the peelers are generally deposited into a flume. At some plants, these shells are recovered by screens for by-product recovery. At other plants, these residuals are discharged into the floor gutter.

Residuals generated at the deveining machines, washers, and final inspections, as well as product spilled at various points throughout the plant, are deposited into the floor gutters. These materials are conveyed in the wastewater discharged by various units. Often these residuals are removed from the plant effluent by screens and deposited into waste hauling trucks for land disposal.

By-products. At some plants the shrimp shells are dried and filled into bags. This material, which contains a high percentage of protein, is used as animal feed. There is no economical utility for the remaining residuals.

Liquid Waste.

Several shrimp processing operations each significantly contributes to the volume of wastewater which is discharged from the plant. The water tanks, in which the shrimp are received, are provided with a continuous overflow. Lubricating and cleaning sprays which are used in peeling and deveining machines contribute significant quantities of organic matter. Washers provided after the cleaning and deveining operations discharge large volumes of wastewater. And the vats used to blanch the shrimp contribute significantly to the organic load.

These wastewater flows, together with the water used to hose down the floors, are collected in the gutter system and ultimately consolidated, generally in a central gutter. The composite waste stream is often screened to remove gross particulates; the plant effluent is then generally discharged directly into a bayou or other receiving water.

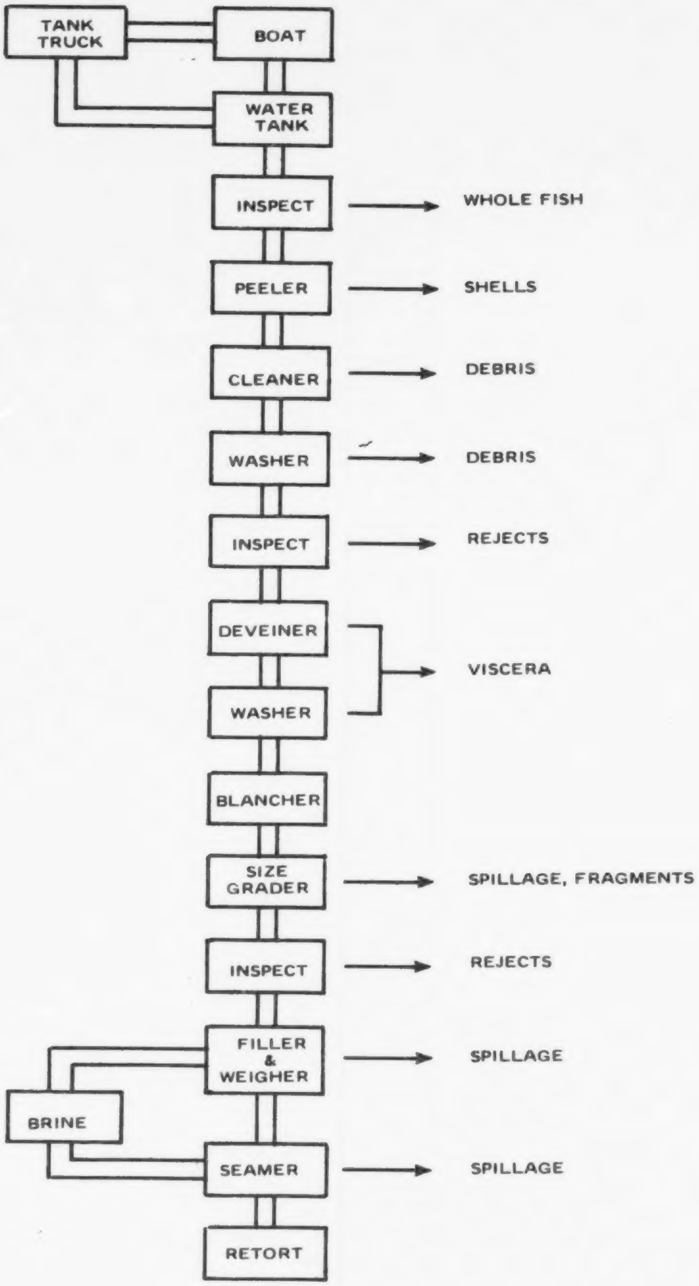
TANK TRUCK
BOAT
WATER TANK
INSPECT
WHOLE FISH
PEELER
SHELLS
CLEANER
DEBRIS
WASHER
DEBRIS
INSPECT
REJECTS
DEVEINER
WASHER
VISCERA
BLANCHER
SIZE GRADER
SPILLAGE, FRAGMENTS
INSPECT
REJECTS
FILLER & WEIGHER
SPILLAGE
BRINE
SEAMER
SPILLAGE
RETORT

Figure 27. SHRIMP -- process flow and sources of product residuals.

Tuna

Harvest and Delivery.

Commercially caught tuna is almost exclusively processed by canning. Four species (yellowfin, albacore, skipjack and bluefin) constitute the bulk of the annual tuna catch. These large, migratory fish appear to be relatively widespread, but the majority are caught in the Pacific Ocean. Large modern boats with 150- to 300-ton capacities and a range of 1,000 miles are used to ply distant waters. Smaller trollers frequent water off the coast of the Western States.

Tuna is commercially caught by the use of seines, as well as by hook and line. Because of the distance which large fishing vessels sail, these boats have provisions for freezing the tuna which is hauled aboard. Fisherman using smaller local boats place the fish directly into the holds and deliver the catch fresh.

Fishing vessels delivering tuna to the processing plant dock at wharves adjacent to the plant. The catch is unloaded by hoist and placed onto drag conveyors or into flumes. The fish are then transported over automatic scales. The weighed fish may be diverted to one of four routes, depending upon the production schedule and whether the fish are delivered fresh or frozen.

Fresh fish are normally conveyed directly to the processing plant. However, if production schedules do not permit immediate processing of a load, the fish may be diverted to a freezer, and then held in cold storage until such time as that load can be rescheduled into the plant. These fish are then handled identically to the fish received prefrozen.

Fish which are delivered in a frozen state are normally flumed to large thawing tanks. Sea water is continuously pumped through these tanks until the fish are thawed and can be scheduled for processing. Loads of frozen fish which cannot be quickly processed are diverted to cold storage. Occasionally, frozen tuna may be thawed in the holds of the fishing vessel during the final day of transport. Fish so prethawed are handled identically to fresh fish and are processed immediately at the time of delivery.

Sea water is used as the transport medium in the flumes commonly used to convey fish from the boats to the processing plant. Fish scales are inevitably scraped from the tuna during transport and thawing. These are carried in the water from the flumes and thawing tanks. Screens are used to remove these materials from the water which is then returned to ocean. The screened materials are collected in portable hoppers or similar containers and conveyed to the by-product recovery plant.

Product Preparation.

Butchering. Fresh or thawed tuna are placed on flat conveyor belts and manually eviscerated. The viscera are recovered for solubles production; frequently, the liver is separated and diverted to an oil recovery operation. The abdominal cavity of each fish is thoroughly washed and manually examined for signs of spoilage. All rejected fish are diverted to the fish meal plant. The heads are semimechanically removed and the tails are removed from the larger fish. Extremely large tuna are cut in half. The tuna and tuna-segments are placed into rectangular wire baskets or cooking trays.

Cooking. The trays of tuna are loaded on racks (carts) which are rolled into large steam chambers. The fish is precooked in these chambers for periods of one to eight hours, depending upon the size of the fish contained therein. A weight loss of 22 to 26 percent, mainly due to loss of moisture and oils, occurs during the process. The oils, together with the condensate from the cooking chambers, are collected and pumped to the solubles plant.

Cooling. After cooking the racks of tuna are rolled into large cooling rooms which are maintained at ambient temperature. The precooked fish is permitted to cool to ambient temperature, requiring up to twelve hours. When cooled the flesh of the tuna is firm, thereby facilitating skin removal and cleaning. No residuals are generated during this process.

Cleaning. The racks are rolled from the cooling room to the cleaning tables. Here the cooked tuna are placed on conveyor belts. Each tuna or tuna segment is manually stripped of its skin and separated into four fillets or loins. The bones are scraped as clean as practical of any adhering meat. The fillets contain both white and red meat. Only the white portion is canned for human consumption. Therefore, the fillets are separated into two flows. The white portions are manually scraped clean of all dark flesh, and directed to the packing operation. The dark meat, commonly referred to as ‘‘blood meat’’, and scrapings are accumulated on a second conveyor and transported to the pet food production line.

The residuals, consisting of skin, bones, tails and heads (if not previously removed) are deposited onto a conveyor and transported to the meal plant. Spillages and scraps are recovered and also diverted to the meal plant.

Filling. Tuna is packed in three styles: solid, chunk and grated. These are semiautomatically filled into cans by special machines. A measured quantity of salt, followed by soya or olive oil, is added to each can. The cans are sealed, washed to remove adhering oil, and retorted. All materials lost to spillage at the fillers are recovered and diverted to the meal plant.

Residuals Handling and Disposal.

Residuals generated during tuna processing are handled either dry or in water, depending upon the unit operation at which the material originates. All residuals, both solid and fluid, are recovered for by-product conversion as described below.

Dry. Rejected whole fish, heads and tails from the butchering tables are accumulated on a common conveyor and transported to the meal plant. Where livers are separated from the viscera, these are collected in portable hoppers or similar containers for transport to an oil recovery operation. The viscera is generally deposited on a conveyor and transported from the butchering room to a solubles plant.

Skins, bones, tails, scraps and spillages from the cleaning tables are deposited onto conveyors for transport to the meal plant. Large bones may optionally be handled separately. If so, these are eventually discharged onto the conveyor carrying the residuals from the butchering tables to the meal plant. Spillages around the fillers are swept up and deposited onto the conveyors transporting smaller residual materials to the meal plant.

Wet. Fish scales and pieces of flesh, which are scraped off during the unloading, fluming and thawing operations, are conveyed in the discharged fluming and thawing waters. These materials are recovered from the water by screens, collected in portable hoppers, and transported to the meal plant.

Oils and fish juices which are leached from the tuna during the cooking operation are collected in floor gutters which are consolidated in a common sump. From here, the fluid mixture is pumped to the solubles plant.

During plant clean-up periods, the floors are first swept. All material accumulated during this period is deposited onto the meal plant conveyors. Residuals washed onto the floor gutters during hose downs are conveyed in the clean-up water to a central point. Gross particulates are removed from the water by screens and collected in portable hoppers. These residuals are transported to the meal plant.

By-products. All residuals, both solid and fluid, from tuna processing are generally utilized for one of several by-products. Each by-product requires a separate production facility. These are individually described below.

Pet Food. The production of pet food from tuna is not a true by-product conversion. Since the dark flesh of the fish is not utilized for canned tuna, pet food lines are provided as an integral part of the overall primary production. The fillets of red meat, as well as the scrapings, are mixed with various ingredients, milled to remove bones, and filled into cans. Brine is added to each can as required; the cans are sealed and retorted.

The bones and scraps, as well as spillages, are collected and conveyed to the meal plant.

Fish Meal. The residuals from the butchering room and the large bones from the cleaning tables are combined and passed through a pre-breaker or hammermill. These materials are combined with the residuals from the cleaning tables, pet food lines, floor sweepings and wastewater screenings. The mixture is passed through a thermal screw and then pressed to remove free moisture and oils. The press cake is milled, dried, ground and stored for bagging and/or shipping. The primary use of fish meal is as a feed supplement, mainly for poultry and fur-bearing animals.

The oils and moisture released during the pre-breaking, cooking and pressing, collectively referred to as press liquor, are collected and pumped to the oil recovery plant.

Oil Recovery. The press liquor is screened to remove particulate matter which is returned to the meal plant. The screened liquor is heated and passed through a gravity separator or centrifuge. The sludge is collected and pumped to the solubles plant; the oil, salable as discharged from the centrifuge, is collected and stored for bulk shipment. Oils recovered from tuna processing are utilized as an additive for feed, as a carrier in paint and varnish formulations, and for several minor applications.

Solubles. The viscera from the butchering tables are ground in a hammermill or grinder; the resulting slurry is pumped to treatment tanks. The fluids collected from the cookers, commonly referred to as stickwater, are mixed with this slurry. Acid is added to the mixture to coagulate the dissolved proteins and to facilitate evaporation of the excess moisture, thereby concentrating the material. The treated mixture is passed through a multi-effect evaporator, resulting in the production of a brown, viscous liquid called fish solubles or fish emulsion. This material is incorporated into animal feeds or used extensively as a plant fertilizer, primarily for home gardening.

Liquid Waste.

The major sources of wastewater from tuna processing are the raw fish conveying flumes, where these are used, and the thawing tanks. These are both located in the receiving area, adjacent to the boat docks. Sea water is used for both fluming and thawing. The effluents from these operations are screened to remove fish scales and other particulates, and returned generally through an outfall pipe to the ocean.

From the product preparation lines the only continuous source of wastewater is from the fish washer at the butchering tables. Additional wastewater flows are discharged during the washing of tuna trays and racks, as well as the general plant cleanup. These flows are combined, screened to remove solid particles, and generally discharged into a municipal sewer system.

In addition to the process wastewaters, most tuna processing plants have fish reduction, or by-product recovery, facilities which contribute various quantities of wastewater to the total effluent. Although the meal plant does not directly contribute to the plant effluent, air scrubbers are generally provided to remove objectionable odors from the gases emanating from the dryer. Sea water is frequently used in the air scrubber and discharged into a floor gutter. The oil recovery plant adds a minor volume of wastewater. Condensate from the multi-effect evaporators is collected and discharged with the plant effluent. All waste streams from the reduction facilities are combined with the process wastewater, screened, and generally discharged into a municipal sewer.

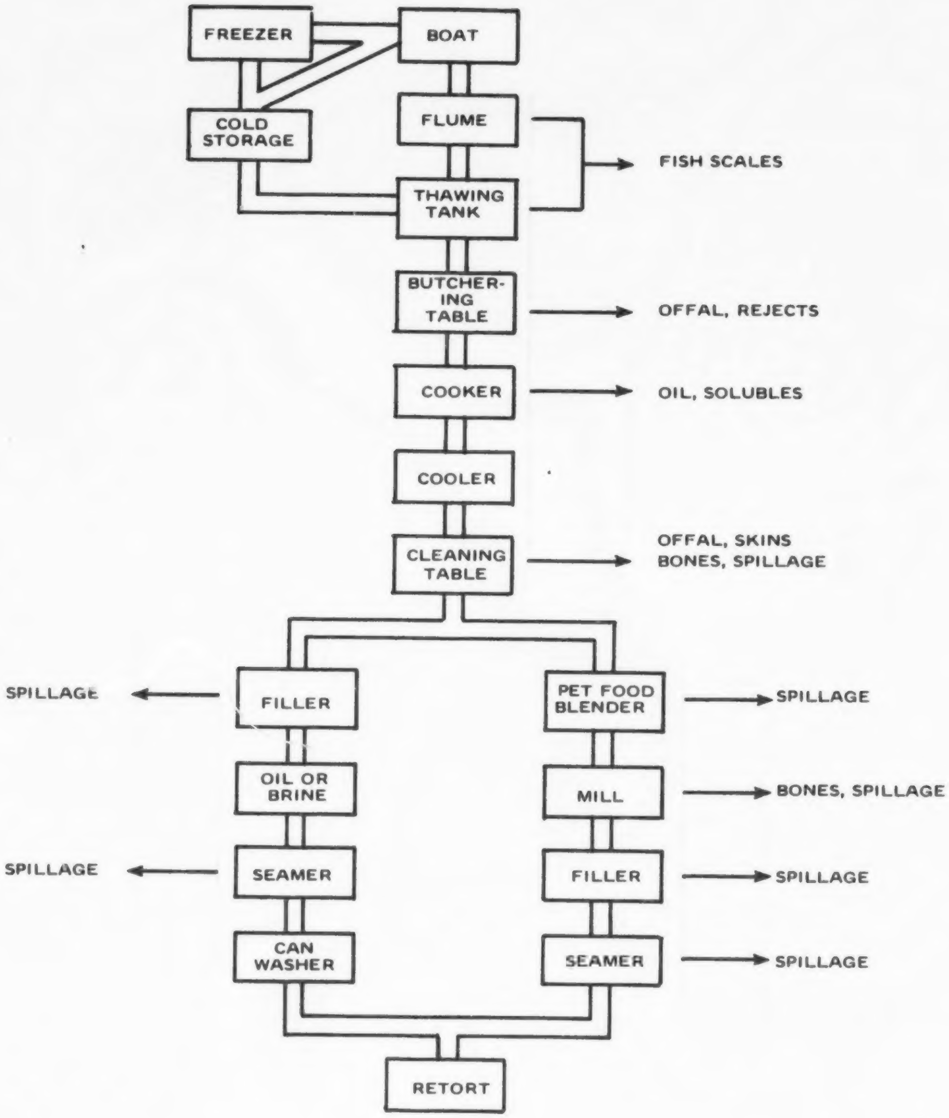
FREEZER
BOAT
COLD STORAGE
FLUME
FISH SCALES
THAWING TANK
BUTCHERING TABLE
OFFAL, REJECTS
COOKER
OIL, SOLUBLES
COOLER
CLEANING TABLE
OFFAL, SKINS BONES, SPILLAGE
SPILLAGE
FILLER
PET FOOD BLENDER
SPILLAGE
OIL OR BRINE
MILL
BONES, SPILLAGE
SPILLAGE
SEAMER
FILLER
SPILLAGE
CAN WASHER
SEAMER
SPILLAGE
RETORT

Figure 28. TUNA -- process flow and sources of product residuals.

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Dry Beans

Harvesting and Delivery.

Dry beans for processing are machine harvested when fully mature. The modern harvester cuts the plants, conveys them to threshing and cleaning equipment within the machine, redistributes plant material in the field, and fills the threshed beans into bags or into a hopper on the machine. Filled bags may be dropped in the field for later hauling; if the hopper is used it must be periodically emptied into bins or bulk truck. Dry beans must be allowed to cure or dry before being put into prolonged storage. Insects common to beans can cause significant damage in storage, so fumigation is necessary. Beans are grown commercially in 14 States and are processed in at least 35 States and one Territory. Shipment from producer to processor is by rail or truck, mostly in 100 pound sacks.

Product Preparation.

Dumping, Soaking. Sacks of beans are dumped into large tanks containing warm water and are allowed to soak for a few hours to rehydrate.

Fluming. The soaked beans and water are discharged from the tank in a continuous stream to a flume with moveable riffle boards in the bottom. Small stones sink to the bottom and are retained on the riffles. The boards are manually lifted from the flume at intervals, the stones dumped to a container and the boards returned to the flume.

Sorting. The beans are flumed or pumped to a dewatering unit and all or part of the water returned to the tank to maintain the fluming operation. The beans are distributed by shaker to a sorting belt where broken beans and trash are removed to containers.

Filling. The sorted beans are conveyed to the filler and filled into cans for further processing.

Residuals Handling and Disposal.

The quantity of residuals from dry bean processing is very small because there are very few foreign material and broken beans included in the raw product. Except for incidental spillage the residuals are handled dry and are discarded.

Dry. The stones from the flume riffles and the broken and cull beans are collected in containers, dumped into a truck and periodically hauled to land disposal.

Wet. A nominal amount of spilled material is flushed to the gutter, flumed to a sump, pumped over a screen and collected in a hopper. Periodically the hopper is emptied into a truck and the residuals hauled to land disposal.

By-product. There is no by-product from dry bean residuals.

Liquid Waste.

Water is used to soak and flume the product, lubricate and clean equipment, operate sterilizing and cooling equipment and to transport residual materials to on-site collection and storage facilities. For conservation of water and efficiency of operation, water is reused as far as practicable, and finally used to transport residual materials.

Major sources of liquid waste include soaking and transporting products in flumes and pumps, washing, and sterilizing and cooling the canned product.

Major sources of dissolved organic matter include product soaking, transporting in flumes and pump, and transporting residuals.

Minor sources of liquid waste include continuous or intermitten washing of belts and equipment, usually by sprays, to assure a clean and efficient operation.

Liquid waste, after screening, is discharged to disposal systems.

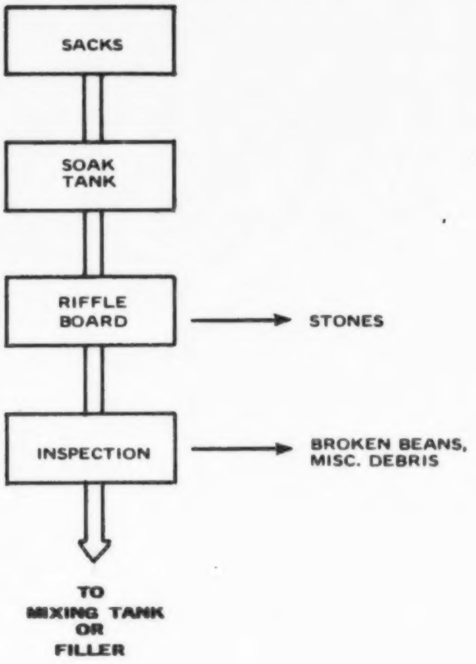
SACKS
SOAK TANK
RIFFLE BOARD
STONES
INSPECTION
BROKEN BEANS, MISC. DEBRIS
TO MIXING TANK OR FILLER

Figure 29. DRY BEANS -- process flow and sources of product residuals.

Specialties

Canned and frozen specialty products include a wide variety of commodities. Most notable among these are baby foods, soups, ethnic foods, health foods, and prepared dinners. Preparation of the numerous items classified as specialties requires the utilization of fruits, vegetables, meats, poultry and dry ingredients (flour, sugar, salt, etc.). A final product is frequently a formulated mixture of several ingredients. The variety and variability in preparation of such products preclude specific discussions of processing procedures. Instead, the following general discussion is provided to indicate the types of residuals which are generated during the production of specialty items.

Product Preparation.

Many specialty processors utilize raw commodities for their production. Fresh fruits and vegetables are received at these plants and are processed in a manner similar to that described in the preceding discussions. Product (food) residuals generated by these plants are essentially as described; the comments regarding residuals handling and disposal also apply to these situations. However, frequently only a portion of these products is processed directly into consumer-size containers. The remainder is bulk-stored for subsequent repacking. Additionally, some specialty processors have provisions for dressing meats and poultry. The residuals from these plants are identical to abattoir and poultry processing wastes.

Processing of specialty products is generally conducted on a year-around basis. For this reason most specialty processors utilize previously-processed and bulk-packaged commodities. These materials are received either canned or frozen in a ready-to-use form and are mixed directly into the desired formulated product. Product residuals are limited to an insignificant quantity resulting from spillages. These residuals are generally swept or hosed into floor gutters.

Residuals Handling and Disposal.

Product residuals generated during the production of specialties are handled both dry and in water. Materials discharged into flumes and/or gutters are normally removed from the wastewater with screens. In most cases the residuals are fed to animals. Where this utility is infeasible, the accumulated materials are disposed of on land.

Since specialties processing frequently involves extensive repacking, large quantities of non-food residuals are generated. These are primarily packaging materials such as plastic sheeting, cardboard cartons, metal containers and lids, and paper. Salvagable and recycleable materials are generally accumulated separately and periodically delivered to appropriate remanufacturing facilities. Plastic, paper and other non-usable materials are accumulated in containers and generally disposed of at public sanitary landfill sites.

Liquid Waste.

Specialty plants which process fresh fruits and vegetables generate seasonal liquid waste loads comparable to fruit and vegetable processing plants. These high-strength waste streams are generally screened to remove solid materials and are discharged to a company-operated treatment and/or disposal system or to a municipal sewerage.

Specialty plants which utilize preprocessed ingredients consume relatively minimal quantities of fresh water. Water taken into these plants is used to rehydrate dried ingredients (where dehydrated materials are utilized), as part of the product mix, to convey residual materials, and to maintain sanitary conditions within the plant. Wastewater from these uses is generally screened to remove gross particulates and is then discharged into a municipal sewer system or to a company-operated treatment and/or disposal facility.

SOLID RESIDUAL QUANTITIES

Introduction

The following data on raw products and residuals pertain to foods processed in the United States by canning, freezing and dehydrating. Dried fruits such as prunes and raisins were excluded. Pickles were included but not condiments or most kinds of sauces. Seafoods held by freezing but marketed like fresh products were omitted, as were meat, poultry and dairy products except those used in soup and other canned and frozen specialties. Most of the data were for 1968. Miscellaneous vegetables, fruit and seafoods were intended to include all of the products not separately listed. U.S. Department of Agriculture production figures were used for raw tonnages where possible. Tonnages of some items had to be estimated from reports of processed packs, converted to raw tons by factors from the USDA and from other sources. The distribution of processing tonnages among regions included some estimates. The least precise data are believed to be those on specialties, on some of the seafoods, and on non-food materials. By ''non-food'' is meant packing and other metal, wood, paper and plastic materials accumulated at food processing plants.

The term ''residuals'' is used for both food and non-food materials in solid form that are not part of the plant's primary output. Parts of the residuals are used in by-products and the rest are disposed of as waste.

In 1968 (the base year for this report) the raw tonnage of ten principal vegetables for processing (excluding white potatoes) was 30% more than the raw tonnage in 1969 and in 1970. The very large 1968 tomato crop was mostly responsible for the difference, although corn and peas were both larger crops in 1968 than in the two following years. The raw tonnage for processing of the principal fruit crops totaled a few percent more in 1969 than in 1968. The total citrus crop was expected to be up 23% in the 1970-71 crop year compared to the base year, but the packs of the principal canned fruits were about 16% less in 1970 than in 1968. Overall it appears that the generation of residuals in 1969 and 1970 was several percent less than the 1968 estimates detailed in this report. However, the long term trend is upward, as demonstrated in the section ''Description of the Industry.'' Figures from timely issues of the periodic reports published by the U.S. Department of Agriculture Crop Reporting Board were used in these comparisons.

Tables A1 and A2 in Appendix B list for each region and each product the solid residuals by month and, separately, by disposal method. Residuals are given to the nearest hundred tons in order to show some entry for the smaller quantities; but because each of the items was based on fewer data than in the tables on the United States totals, the estimates are in fact less precise. When items of data were lacking they were estimated by data from adjacent regions.

Table A3 in Appendix B summarizes similar data under products and includes for each product: the estimated raw tons utilized in each region; the number of plants packing the product in the survey; the percentage of the total raw tons in the survey sample; the estimated percent yield; the average raw tons per plant in the survey; residual tons by region and month; and residual tons by region and disposal method. (The number of plants and the average raw tons per plant are not given for products represented by only a few plants in the survey). These data are given to the nearest 1000 tons. As in other sections of this report, the more detailed the breakdown of the data, the less precisely they are known.

Residuals by Product and Month

Table 32 lists estimates of the total solid residuals from each product each month, the total residuals for a year, and the total tonnage of raw product delivered to the industry. Non-food wastes are given separately; the main part of the table deals with residuals that originated as part of the food product (including inedible parts such as cobs and shells). The distributions of residuals among months are not as precisely known as are the totals.

Table 32 reflects the highly seasonal operations on such products as corn, tomatoes and peaches in contrast to the nearly continuous operation on specialties and minor month-to-month fluctuations in processing potatoes, some seafoods and other products. Seasonal operation is even more marked within regions as compared to the United States as a whole (regional data by months are in Tables A1 and A3). More than 33 million tons of raw food products were used by the industry, and more than 9 million tons of solid residuals were generated. Relatively few products accounted for the bulk of the raw tonnage and of the residuals generated by the industry; for example, about 70% of each were from citrus, tomatoes, white potatoes, corn and specialties combined, and more than half were from the first three of these products. Non-food residuals were only a small fraction of the total.

Residuals by Product and Disposal Method

Table 33 lists the same total residuals and raw tons as the previous table, but distributes the residuals according to disposal method. Three columns break down the tonnages handled as solid (sometimes wet solid) wastes, and are summed in the column ‘‘total as solid’’. ‘‘Fill’’ does not imply frequent covering and compacting; practices varied from these to simple dumping. ‘‘Spread’’ disposal is usually on agricultural land and may or may not include disking. ‘‘Burn’’ refers to the materials, mostly non-food, burned at the site of the food processing plant.

TABLE 32

INDUSTRY SOLID RESIDUALS BY PRODUCT AND MONTH

Product	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sept	Oct	Nov	Dec	Total	Raw Tons
asparagus			4	14	14	9	2	x					42	120
lima bean						x	x	5	8	5	x	x	19	120
snap bean				2	2	7	37	41	35	9	1		130	630
beet	2			2	1	1	9	16	18	22	14	3	90	270
broc., sprouts, cauliflower	7	6	7	7	6	7	5	13	13	16	16	10	110	260
cabbage	4	4	4	3	2	1		8	14	16	14	7	76	230
carrot	6	3	4	5	4	5	9	10	23	33	26	12	140	280
corn						8	70	620	590	280	48		1620	2480
greens, spinach	2	2	8	7	3	1		x	2	2	3	2	33	240
mushroom	3	3	3	3	3	3	2	2	2	3	3	3	32	67
pea				1	5	25	28	11	1	x	x	x	74	580
wh. potato	99	90	92	86	90	62	69	100	110	130	130	120	1170	3570
pump./squash							1	12	10	22	10		55	220
tomato	7	7	6	6	10	70	140	150	110	6	6		520	6970
vegetable, misc	11	12	12	11	17	19	30	38	36	38	32	16	270	1220
apple	28	21	15	5	4			2	33	53	64	56	290	1050
apricot	x	x	x	x		6	7						16	120
berry	x	x	x	x	x	3	3	4	2	x			14	200
cherry					x	1	13	11					26	190
citrus	330	330	330	330	330	330	210	100	100	160	210	330	3080	7800
fruit, misc	x	x	x	x	1	3	4	8	9	8	2	1	36	150
olive	1	1	x		x	x	x		2	3	3	x	11	85
peach						23	84	99	83	3			290	1100
pear							14	33	39	25	6		120	410
pineapple	25	25	30	50	55	55	55	55	30	25			400	900
plum, prune	1	1	1	x		1	x	x	1	1	x	x	7	27
dry bean	1	1	1	1	x	x	x	x	x	1	1	1	7	230
pickle	x	x	x	x	x	8	9	8	8	6	x	x	41	560
specialty	26	26	26	26	25	24	23	24	24	25	25	26	300	2500
clam, scallop	1	1	1	1	1	1	1	1	1	1	1	1	13	90
oyster	3	3	2	2	x					2	2	3	18	20
crab	2	2	2	2	1	2	1	2	2	2	2	2	22	30
shrimp	5	7	7	6	8	5	5	5	5	5	5	5	66	120
salmon	x	x	x	x	x	8	12	10	8	2	x		40	124
sardine	x	x	1	1	x	1	1	1	1	x	x	x	6	26
tuna, misc. seafood	7	7	7	7	8	8	9	10	10	9	9	7	99	520
TOTAL	570	550	560	580	590	700	860	1400	1330	920	640	600	9310	33500
Non-Food	39	38	40	43	43	55	69	76	78	73	49	43	650	-

All figures x 1000 tons; rounded (after adding)
x = 500 tons or less

TABLE 33

INDUSTRY SOLID RESIDUALS BY PRODUCT AND DISPOSAL METHOD

Product	total raw tons¹	fill	spread	burn	total as solid	water	pond	sewer	irrig	total in liquid	feed	other	total by-products	total resid-uals	not acc't. for
asparagus	120	8	16		24					0	19		19	42	3
lima bean	120	1	8		10					0	10		10	19	(-3)
snap bean	630	35	32		67		x	3		3	64		64	130	0
beet	270	18	46		65			6		6	18		18	90	21
broc., sprouts, cauliflower	260	12	9		21			1		1	91		91	110	x
cabbage	230	19	44		64		6			6	6		6	76	(-1)
carrot	280	6	30	x	36			2		2	100	x	100	140	10
corn	2,480	3	86	x	89			2	1	3	1,530		1,530	1,620	42
greens, spinach	240	5	3		8		x	x		x	24		24	33	4
mushroom	67	4	28		32	x				x			0	32	(-2)
pea	580	3	22	x	24					0	49	x	49	74	4
wh. potato	3,570	57	28		85	42	2	4		48	1,040		1,040	1,170	170
pump./squash	220	8	13		22		x	9		9	24	2	25	55	97
tomato	6,970	250	130	x	380	21	7	x	1	30	120		120	520	150
vegetable, misc.	1,220	38	71	4	110		1	52		52	110		110	270	x
apple	1,050	35	54		90	x	x		x	x	110	87	200	290	30
apricot	120	4	2		6	x				x	7	2	9	16	5
berry	200	4	5	1	10	2	x	x		2	1		1	14	2
cherry	190	15	5	x	20				1	1	4	x	4	26	1
citrus	7,800	4	76		80				1	1	3,000	3	3,000	3,080	310
fruit, misc.	150	13	13		25			x		x	8	2	10	36	3
olive	85		1	x	2		x			x		10	10	11	x
peach	1,100	130	56		180	13	x	1	x	14	50	44	94	290	(-19)
pear	410	40	32		72	10		x		10	36		36	120	14
pineapple	900	30			30	5		5		10	360		360	400	0
plum, prune	27	4	2		6	1				1	x		0	7	1
dry bean	230	3	2	x	6			x		x	2		2	7	(-1)
pickle	560	37	3		40			1		1			0	41	(-15)
specialty	2,500	37	3	8	48		7	18	x	24	210	17	230	300	0
clam, scallop	90	8	4		12	x				x			0	13	65
oyster	20				0	2				2		16	16	18	x
crab	30	5	1		6	16				16			0	22	1
shrimp	120		4	3	7	29		12		41	16	x	17	66	20
salmon	120				0	35				35	4	2	6	40	3
sardine	26				0					0		6	6	6	x
tuna, misc. seafood	520				0	x				x	69	30	99	99	91
TOTAL	33,500	830	830	18	1,680	180	24	120	5	320	7,080	220	7,300	9,310	1,010
non-food		300	17	97	410	x	32			32	metal 130	other 67	200	650	--

¹All figures x 1000 tons; rounded (after adding)

x = 500 tons or less

Tonnages of solid residuals disposed of in a liquid medium are listed in four columns and as a total. ''Water'' means a stream, lake, bay or ocean; ''pond'', a holding or treatment pond; ''sewer'', a public treatment system; and ''irrig'', disposal by irrigation. Small percentages of all products are leached or comminuted and disposed of in the plant liquid waste stream aside from the tonnages listed; these quantities were not available in the project data and they have not been estimated.

By far the largest proportion of by-products from food processing residuals went into animal feed. The column headed ''other use'' includes smaller amounts for charcoal, alcohol, oil, vinegar, and some other products. Non-food by-products have separate headings--''metal'' and ''other''; the latter is mostly recovery of paper and cardboard.

The column of tonnages of residuals ''not accounted for'' arises from two methods of computing the quantity: (a) from the tonnages listed as residuals in the survey questionnaires, and (b) from applying the percent yields reported in the questionnaires to the total raw tons also given in the questionnaires. (In both cases the sample results have been extended to the entire tonnage of raw product for the whole United States.) The data in all three of the tables in this section were estimated from the first of these methods. The differences between the two calculated tonnages should be moderate amounts that go to leaching into waste water, evaporation and other product shrinkage in the time between weighing the raw product and processing it, and the like.

Of the million tons not accounted for, 630,000 tons were from citrus, tomatoes and white potatoes, and only 4, 2, and 5%, respectively, of the total raw tons of these products were unaccounted for. Shrinkage after weighing the raw product and before processing is expected at least for tomatoes and potatoes. The large quantity of pumpkin and squash lost, 97,000 tons, probably came from discrepancies in the methods of reporting the data; these products lose a large proportion of their weight as water during processing. The relatively large residual tonnages of some seafoods not accounted for may also have arisen from reporting errors; the 65,000 tons from clams and scallops must be shell. Some of the unaccounted for tonnages were negative, probably from errors of estimate of the percent yields or of the residual tons disposed of. Data on peach tonnages were possibly inaccurate because of a complex system of diverting fruit at various stages of processing in California.

Table 33 illustrates wide variations in disposal practices from product to product. More than three-fourths of the total food residuals were used in by-products. About 5.6 of the total 7.1 million tons of residuals used as feeds were from only three products: citrus, corn, and white potatoes. These are all large crops, producing large percentages of residuals, and generally processed in regions where there are livestock to consume the residuals. Citrus and potatoes are processed the year around and corn residuals are made into silage which can be stored; the feed by-products are therefore available over long periods. Some of the tonnages reported as fed to animals were spread on the land for livestock to eat. No doubt, portions were trampled in and wasted. On the other hand, some of the tonnages reported (and summarized) as waste spread on land were probably handled in the same way. Only 3% of the food by-products were for uses other than animal feed. These included oil from olives, charcoal and other by-products from peach and apricot pits, vinegar from apples, alcohol from various fruits, oil and fertilizer from some seafoods, and oil and other by-products from citrus.

Fill and spread methods were about equally utilized for solid waste disposal, but the proportions to each of these methods varied widely among products. Only small quantities of residuals were burned at the plant site; some disposal operations away from the plant included burning. Very few of the industry's food waste products would burn without prior dehydration (cull dry beans, onion skins, and a few others), but much of the non-food waste is paper, cardboard and wood.

Disposal of residuals to ''water'' (stream, lake, bay, ocean) was in large measure by seafood plants returning fish and shellfish remains to the medium from which they came. Small percentages of the residuals from several fruits and vegetables were barged to the open ocean for disposal. Small quantities of solid waste were disposed of in company-operated treatment ponds and irrigation systems or municipal plants.

Residuals by Region and Disposal Method

Table 34 gives tonnages of residuals by the following categories: region; disposal method; and food, non-food and total. See preceding for explanation of tonnages not accounted for.

Overall variations in disposal practices among regions of the United States are shown in Table 34. Much of this variation is associated with different products processed in different regions. For example, citrus dominates in the South Atlantic; and potatoes make up a large fraction of the North West raw product, as do tomatoes in the South West; all production in Alaska is of seafoods. Many other factors influence disposal practices; for example, nearness to open land, accessibility to a livestock industry, seasonality of the prodct, plant size (and, therefore, the quantity of residuals), and such characteristics of the product residuals as moisture and nutritive content.

The survey sample bias toward larger plants must have affected the data on disposal method but not by very much because most of the tons of residuals were from the larger plants.

TABLE 34
INDUSTRY SOLID RESIDUALS BY REGION AND DISPOSAL METHOD

Region	total raw tons	fill	spread	burn	total as solid	water	pond	sewer	irrig.	total in liquid	(meal) feed	(other) other	total by-products	total residuals	not acc't. for
New England															
food	980	3	5	1	9	23	x	2		25	115	16	130	170	180
non-food		3		2	6					0			0	6	
total		6	5	3	14	23	x	2		25			130	170	
Mid Atlantic															
food	2,060	116	164	x	280		6	1		7	109	65	170	460	130
non-food		16		1	17					0	(68)	(34)	100	120	
total		132	164	1	300		6	1		7			280	580	
South Atlantic															
food	8,320	66	157		220	2	2	64	x	68	2,686	14	2,700	2,990	330
non-food		26		38	64					0	(6)		6	70	
total		91	157	38	290	2	2	64	x	68			2,700	3,060	
North Central															
food	5,890	141	247	9	400	x	12	13	3	28	1,274	20	1,300	1,720	62
non-food		81		17	98					0	(27)	(21)	49	150	
total		221	247	26	500	x	12	13	3	28			1,300	1,860	
South Central															
food	1,220	23	28	3	54	8	x	17	x	25	215	7	220	300	43
non-food		42		8	50					0	(21)	(4)	24	70	
total		65	28	11	100	8	x	17	x	25			250	380	
Mountain															
food	240	16	3		20		2	2		3	46		46	69	13
non-food		2		x	2					0			0	2	
total		18	3	x	22		2	2		3			46	71	
Northwest															
food	4,310	102	48	x	150	43	2	11	x	57	1,393	13	1,410	1,610	110
non-food		53		12	65		32			32	(x)	(x)	1	98	
total		155	48	12	220	43	34	11	x	89			1,410	1,710	
Alaska															
food	160				0	50				50	3	4	7	57	6
non-food		x	x	x	1	x				x			0	1	
total		x	x	x	1	51				51			7	58	
Southwest															
food	10,310	365	184	4	550	50	x	10	1	61	1,308	83	1,390	2,010	130
non-food		78	17	17	110					0	(12)	(8)	20	130	
total		443	201	21	660	50	x	10	1	61			1,410	2,140	
U.S. TOTAL															
food	33,500	830	830	18	1,680	180	24	120	5	320	7,080	220	7,300	9,310	1,010
non-food		300	17	97	410	x	32			32	(134)	(67)	200	650	
total		1,130	850	114	2,090	180	56	120	5	350			7,500	9,950	

All figures x 1000 tons; sub-totals rounded (after adding)
x = 500 tons or less

SOLID RESIDUALS MANAGEMENT

Introduction

The previous sections describe for each major commodity the processing operations which generate solid residuals and the general characteristics of the residual materials, and summarize the quantity, geographic distribution and seasonality of residuals generation.

The characteristics of the residuals frequently dictate the means by which the materials can be practically managed - i.e., methods which can be employed to handle, accumulate, store, and ultimately dispose of these solid wastes. Plant size and geographic location also influence management practices. Therefore, the information which has been elicited during this program regarding solid residuals management is summarized in this section with consideration given to these factors.

In-plant Handling Methods

The questionnaire included items designed to identify sources of residuals for each commodity and the methods employed for the in-plant management of these materials. In general, these items were answered in insufficient detail. During the site-visit phase of the program, emphasis was placed on the development of the desired information. The results are summarized in Tables 35 through 38 and discussed in the following.

The sources of residuals are listed on each table. The number of plants (frequency) at which each source was found to be a major contributor to the solid residuals load is expressed as a percentage. However, since certain operations create residuals from some products and not others (for example, washing of beets and other root vegetables versus washing of snap beans or peas), the reported values are not to be construed as reflecting the number of plants which conduct those listed operations.

The frequency with which the various methods are employed in handling the residuals from each source is also tabulated as a percentage. Some plants utilize more than one method for handling residuals from a single source; therefore, the total is frequently greater than 100 percent.

TABLE 35
SUMMARY OF IN-PLANT HANDLING METHODS FOR FRUIT, VEGETABLE, AND TOMATO RESIDUALS*

Waste Source	In-plant Handling Method					Frequency as waste source
	Continuous			Container	Gutter	
	Dry	Wet	Wet & Dry			
Dry Cleaning	36	5	2	27	33	61
Washing	0	12	0	13	82	56
Size Grading	40	6	4	15	36	23
Trimming	38	11	1	16	37	47
Initial Sort	17	8	3	35	48	46
Cutting, Slicing, Dicing	42	6	1	11	40	30
Peeling	9	4	2	0	85	36
Quality Grading	0	7	0	7	86	6
Pitting	15	59	19	7	7	11
Final Sort	8	5	3	29	63	80
Pulping, Finishing	39	6	0	16	51	22

*All values in percent.

TABLE 36
SUMMARY OF IN-PLANT HANDLING METHODS FOR RESIDUALS FROM FRUIT PROCESSING*

Waste Source	In-plant Handling Method					Frequency as waste source
	Continuous			Container	Gutter	
	Dry	Wet	Wet & Dry			
Dry Cleaning	50	18	2	20	11	80
Washing	0	8	0	0	92	24
Size Grading	81	13	6	0	0	29
Trimming	20	12	0	28	44	45
Initial Sort	11	4	11	71	21	51
Cutting, Slicing, Dicing	39	11	0	11	39	33
Peeling	23	6	6	0	64	56
Pitting	15	59	19	7	7	49
Final Sort	12	10	4	37	39	93
Pulping, Finishing	29	14	0	43	50	25

*All values in percent.

TABLE 37
SUMMARY OF IN-PLANT HANDLING METHODS FOR RESIDUALS FROM VEGETABLE PROCESSING*

Waste Source	In-plant Handling Method					Frequency as waste source
	Continuous			Container	Gutter	
	Dry	Wet	Wet & Dry			
Dry Cleaning	32	1	1	29	40	68
Washing	0	10	0	4	87	58
Size Grading	22	3	3	22	51	26
Trimming	43	11	1	13	35	60
Initial Sort	25	10	0	25	50	36
Cutting, Slicing, Dicing	43	4	2	11	41	36
Peeling	3	0	0	0	97	20
Quality Grading	0	7	0	7	86	10
Final Sort	7	3	2	31	68	78
Pulping, Finishing	50	0	0	17	33	4

*All values in percent.

TABLE 38
SUMMARY OF IN-PLANT HANDLING METHODS FOR RESIDUALS FROM TOMATO PROCESSING*

Waste Source	In-plant Handling Method					Frequency as waste source
	Continuous			Container	Gutter	
	Dry	Wet	Wet & Dry			
Fluming, Washing	0	17	0	40	46	100
Initial Sorting	7	7	0	21	71	80
Peeling	0	4	0	4	92	72
Final Sorting	4	4	4	0	91	66
Pulping, Finishing	42	3	0	3	55	89

*All values in percent.

Description of Commonly Employed Methods. The methods which are used to accumulate and/or convey residuals from the processing plant are listed under the following categories:

> Continuous dry handling methods include the use of conveyor belts, screw conveyors, vibrating conveyors, elevators, and pneumatic systems, each of which continuously removes residuals from the point of generation. Such systems require the addition of little or no water, thereby eliminating the necessity of solids-liquid separation devices and greatly minimizing the quantity of material lost to the liquid waste.
>
> Continuous wet handling systems include the use of flumes and pumping systems. Previously-used process water is frequently utilized in such hydraulic conveying systems. These require dewatering devices, such as bar racks or screens, for removal of solid residuals from the water. Soluble solids are leached from the product conveyed in this manner; the added weight of water which adheres to the solids may significantly influence the weight and moisture content of the residuals.
>
> Continuous wet and dry methods include combinations of any continuous dry method with any continuous wet method. For example, residuals which are deposited onto a conveyor belt and subsequently transferred into a flume would be listed as being handled by this method. The comments pertaining to continuous wet handling systems would apply to this situation.
>
> Containers include buckets, pans, barrels, bins, portable hoppers, boxes, etc. and are considered as dry handling methods. Containers may be positioned beneath residuals generating equipment or located at inspection belts where materials are manually deposited. Residuals so accumulated are periodically removed from the point of generation.
>
> Materials deposited into floor gutters are hydraulically conveyed from the processing area. Gutters may be periodically or continuously flushed, frequently by wastewater from various equipment. Residuals so handled lose soluble solids to the liquid waste while frequently gaining weight as excess water.

The method by which the residuals from each source are handled appears to be unrelated to plant size or geography. Since product preparation steps for any specific product are similar for canning and freezing, no significant variations exist between the methods utilized by the two types of processing plants. Rather, the method is determined more by the characteristics of the residuals as influenced by the unit operation which generates the material. This is discussed in more detail below.

Handling Methods for Residuals from Specific Sources. The characteristics of residual materials are greatly influenced by the unit operation responsible for their generation. Residuals which consist of large and relatively ''dry'' particles lend themselves readily to dry handling methods. Materials which are discharged in water from a unit operation are most practically handled hydraulically. Frequently, however, the choice of an in-plant handling method is based solely on convenience.

For discussion purposes, the major waste generating operations have been grouped into eleven categories. Not all of these apply to each major commodity. The descriptions in the Products and Processes section should be referred to for operations involved in the production of specific products.

Dry Cleaning. Dry cleaning operations are provided for removing soil, leaves, vines and other extraneous debris from delivered raw product prior to processing. Air cleaners (up-draft blowers), shakers, revolving reels and large-mesh steel belts are most frequently used for this purpose and are normally situated in the receiving area of the processing plant. Residuals generated by dry cleaning can generally be readily handled by dry methods, such as by belts or containers. Fruit and vegetable processors do, in fact, utilize dry handling methods most frequently (70% and 61% respectively, by continuous dry methods and containers). However, a significant number of plants discharge these materials into gutters and/or fluming systems (29% and 41% for fruit and vegetable plants, respectively), mainly for convenience of transporting residuals from the often remotely situated receiving area to on-site residuals accumulation and storage facilities.

Washing. Raw products delivered to the processing plant are washed in dump tanks, in flood washers, in revolving drums, with overhead sprays situated above conveyor belts, or in flumes. The quantity and nature of residuals generated during washing varies widely from product to product. Root vegetables, such as beets and potatoes, are delivered with a significant quantity of soil adhering to the product. Mechanically harvested tomatoes are also frequently smeared with soil, as well as being mixed with dirt clods, leaves and vines. Washing of these products results in the generation of mud which must be handled as a residual. Mechanically harvested fruits and vegetables are mixed with leaves, twigs, vines, and similar debris. When washers are not preceded by dry cleaning operations, these materials are removed during washing.

Soil, leaves, stems, and miscellaneous debris are separated from the raw product by and discharged with the washwater. Therefore, the residuals generated by washers are generally handled hydraulically, most frequently by the direct discharge of both solid and liquid wastes into floor gutters. However, residuals from some products are separated by flotation. Most notable are the froth cleaners or flotation washers used by pea, lima bean, and some corn processors. Residuals from these sources are normally dewatered immediately after discharge from the washer and are deposited into containers for subsequent dry handling.

Residuals from tomato washers are frequently handled in containers (40%). Leaves and vines from mechanically harvested tomatoes accumulate as floating debris in the washing flumes and are periodically removed and deposited into containers. However, the bulk of the residuals from tomato washers consist of mud which is often separated from the washwater with the aid of cyclone separators or by simple settling tanks. The resulting aqueous slurry is frequently collected in tanks or other containers for subsequent disposition.

Size Grading. Many fruits and vegetables are divided into several sizes to facilitate the performance of subsequent operations and to assure a degree of uniformity in the final product. Commonly used size graders include revolving cylinders or vibrating tables which are perforated with increasingly larger openings, and divergently spaced rollers or narrow belts. Undersized product and fragments are removed at the smaller openings or spaces. These residuals can be readily dry handled, as is widely done for fruits and vegetables (81% and 44%, respectively). However, vegetable residuals from size graders are discharged most frequently (57%) into hydraulic systems, mainly as a matter of convenience.

Although size graders are widely employed, they are a major source of residuals generation in only 23% of the plants. Many products are processed into several styles, some of which utilize product regardless of size. For example, tomatoes which are either too small or too large for the whole peel pack are diverted to crushers for the production of juice, sauce and other tomato products, thereby eliminating the size grader as a waste source.

Trimming. Trimming operations, as used here, include cherry stemming, asparagus butt cutting, bean snipping, and corn husking, as well as the manual removal of defective and unusable portions from these and other commodities. Generally, residuals from trimming operations can be dry handled. For example, corn husks, cabbage leaves and apple trimmings are almost exclusively handled by continuous dry systems. In practice, however, fruit and vegetable trimmings are handled with equal frequency by dry and hydraulic methods.

Initial Sorting. Raw food products may be visually examined at various stages early in the process flow. Culls, fragments, over-ripe and immature product, and miscellaneous debris are manually removed from the product stream, generally as the product is being conveyed on belts or vibrating conveyors past the inspection stations. Residuals generated at initial sorting stations are handled with equal frequency by dry and hydraulic methods (52% and 59%, respectively). Fruit residuals are most frequently deposited into containers, while vegetable and tomato residuals are discharged most frequently into floor gutters.

Cutting, Slicing, Dicing. Numerous product styles are created by reducing the size of some raw products. With the exception of corn kernels which are cut from the cob and cabbage which is shredded for sauerkraut, these operations are mechanically conducted for the sole purpose of creating such style varieties. The cutting, slicing or dicing of fruits and vegetables often results in the generation of residuals consisting primarily of small fragments. These residuals may be separated from the product by one of several methods, including pneumatic separation, manual sorting, and vibrating sieves or screens.

Corn cobs are almost exclusively handled by continuous dry methods, as are most residuals from peach slicing operations. Peach dicing and pear slicing and dicing residuals are most frequently discharged into floor gutters. Residuals from other products are handled with equal frequency by dry and hydraulic means.

Peeling. All commonly used peeling equipment can be categorized as either mechanical or chemical peelers. Mechanical peelers include automatic fruit parers and abrasive rollers for vegetables; chemical peelers employ a caustic solution, generally heated to facilitate softening of the skin tissue, and are used for both fruits and vegetables. The type of peeler which is used markedly influences the characteristics of the residuals generated at this waste source.

Automatic paring machines are used extensively to peel and simultaneously core apples and pears. The relatively dry peel and core materials from apples are extensively handled by continuous dry methods, primarily due to the utility of these residuals for by-product conversion; pear residuals are most frequently conveyed hydraulically. Residuals from all other types of peelers are generally discharged with the water which is used by the equipment and are thus almost exclusively handled hydraulically. These include abrasively peeled beets and carrots; chemically peeled apples, apricots, peaches, pears, and tomatoes; and beets, carrots and white potatoes which are peeled by a combination of chemical and abrasive equipment. The predominant use of hydraulic handling systems is reflected by the 91% frequency for peeling residuals from all products.

Quality Grading. The quality of peas and lima beans is a function of the maturity of the product and is reflected by the starch content. The concentration of starch affects the specific gravity of the peas and lima beans. Brine solutions are utilized to take advantage of the density differential. Overly-mature product is separated by flotation. These residuals are dewatered from the brine and discharged most frequently into floor gutters.

Pitting. Apricots, cherries and peaches are mechanically pitted. Depending upon the type of pitter which is used, the pits are automatically separated from the fruit at the time of destoning, or shaker sieves must be subsequently provided to effect separation. The pits from these products are utilized for manufacturing a variety of by-products. However, fruit flesh adhering to the pits is undesirable. For this reason, hydraulic handling methods, which have the effect of washing the pits, are most frequently employed. Cling peach pits, which have excessive amounts of adhering flesh, are often passed through a revolving cylinder to further facilitate removal of fruit fragments.

Final Sorting. All food products are visually inspected before being placed into containers or packages. Unacceptable materials are manually removed and discarded. The quantity of residuals generated during final inspection, and thus the significance of the operation as a waste source, is largely influenced by the degree of quality control (sorting, trimming, etc.) conducted prior to this point. Fruit residuals generated at final inspection stations are handled with equal frequency by dry and hydraulic methods (49% and 53%, respectively). Vegetable and tomato residuals are most frequently handled hydraulically.

Pulping and Finishing. Pulping and finishing operations are commonly conducted in tomato processing plants, less frequently in fruit processing plants, and are generally limited to pumpkin in the other major vegetable processing plants. Residuals from these operations consist of skin, seeds, stems, fiber, and relatively fine particles. Residuals from fruit and vegetable pulpers and finishers are more frequently handled by dry methods; residuals from tomato pulpers and finishers are more frequently handled hydraulically.

On-Site Accumulation and Storage

Residuals which are handled by dry methods are normally conveyed directly to the on-site storage facility, while residuals which are handled hydraulically are normally removed from the water by screens and deposited into the on-site storage facility. Information regarding screening and storage facilities is discussed below.

Screening. Specific data were collected on the screens which separate solid wastes from the liquid waste stream.

Number and sizes of screens. The percentages of plants using different types and sizes of screens for separating solids from their liquid waste streams are in Table 39.

TABLE 39
TYPES AND SIZES OF SCREENS

Type of Screen	New Eng.	Mid Atl.	South Atl.	North Cent.	South Cent.	Mount-ain	North West	Alas-ka	South West	Total
Static	7	9	25	2	0	0	6	0	4	6
Vibrating	14	46	44	66	26	64	63	0	64	54
Revolving	0	16	17	17	16	36	17	0	15	16
Belt	0	16	8	9	11	9	3	0	10	8
Other	0	2	0	2	0	0	0	0	2	1
None	64	26	19	12	47	0	13	91	8	20
Meshes per inches										
5-	0	0	0	1	0	0	4	--	3	2
5-14	0	7	27	23	44	0	4	--	25	17
15-24	50	61	41	48	33	55	61	--	56	51
25-34	0	7	14	14	11	0	9	--	4	9
35-54	50	18	14	11	0	44	18	--	8	13
55+	0	7	5	3	11	0	5	--	4	4

Type of Screen	Fruit	Tomato	Vege-table	Sea-food	Special-ty	Can Only	Can & Freeze	Freeze Only	Any Dehdr.
Static	10	3	5	0	8	3	11	4	29
Vibrating	57	64	67	8	39	54	42	49	65
Revolving	12	13	18	0	25	14	11	25	18
Belt	12	3	9	0	4	7	9	8	6
Other	1	0	0	0	1	0	0	2	0
None	7	13	4	76	27	19	23	16	6
Meshes per inch									
5-	3	0	2	0	2	2	0	0	7
5-14	13	13	15	3	40	17	4	28	20
15-24	58	67	55	0	36	58	44	52	20
25-34	3	10	9	0	13	9	13	8	7
35-54	18	10	17	3	9	12	35	8	33
55+	4	0	3	3	0	2	4	3	13

The columns may add to less than 100% because data were lacking from some plants or to more than 100% because some plants used more than one screen type or mesh size. The tabulated figures are biased; see the discussion of screens and plant sizes, below.

By far the commonest type was a vibrating screen, with revolving screens next. One-fifth of the plants used no screens. The percentages without screens were significantly high in the Alaska, New England, and South Central regions, and in seafood plants; and were significantly low in the South West, and in fruit and vegetable plants. (Significance was estimated from the difference between the number of plants in a given category and the number of plants expected in the category if all regions, commodities, or processes were the same.)

About half the screens had approximately 20 meshes per inch. South Central and specialty plants had significantly more 10-mesh screens than average, and North West plants had significantly fewer. Plants where both canning and freezing were done and dehydrating plants had significantly more fine-mesh screens than average.

The type of screens in use varied significantly with plant size; see Table 40 (percentages of plants).

TABLE 40
SCREEN TYPE AND PLANT SIZE

Type of Screen	Plant size, 1000 raw tons/year 0-1	1-5	5-25	25-100	100-200	over 200
Vibrating	14	21	74	80	86	67
Revolving	0	9	17	26	14	44
Other	9	20	13	16	19	44
None	78	55	10	5	0	11

The percentage of plants with no screens declined with increasing plant size, only partly because many seafood plants were small and used disposal methods not requiring screens. The percentages of non-seafood plants without screens in the two smallest plant size categories were 73 and 34, respectively. Since the survey sample over-represented large plants and under-represented small plants, the data on the percentages of plants with screens (by regions, products and processes) were biased. A very rough estimate of the true number of plants in each size category is developed elsewhere in this report (see the discussion of costs). Using this estimate to correct the bias in the sample data on screens resulted in doubling the overall percentage of plants without screens. However, at least 85% of the industry's production is probably from the four larger plant size categories, where more than 90% of the plants used screens.

Plant size had almost no effect on the size of screens used except that the largest plants (more than 200,000 raw tons) tended to use either coarser or finer screens rather than 20-mesh.

Proportions of Waste Streams Screened. The survey questionnaire asked for the percentage of each waste material that was screened. Averages of the resulting data cannot be precise; screening is not appropriate for solid residuals handled dry or disposed of by some methods; portions so handled or disposed of would lower the percentages reported as screened. Some products have been omitted from Table 41 because too few figures were reported on them. Data have been rounded to the nearest 10%.

TABLE 41
PERCENTAGES OF WASTES SCREENED

Product	% Screened	Product	% Screened
Asparagus	70	Apple	30
Bean, lima	70	Apricot	60
Bean, snap	70	Berry	70
Beet	80	Cherry	50
Broc., cauli., sprouts	60	Citrus	40
Cabbage	40	Fruit, misc.	30
Carrot	80	Peach	60
Corn	30	Pear	90
Pea	80	Plum, prune	70
Potato, white	80	Crab	0
Pumpkin, squash	70	Shrimp	20
Spinach, greens	60	Salmon	0
Tomato	70	Sardine	0
Vegetables, misc.	60		
Bean, dry	80		
Pickle	40		
Specialty	50		

The figures in Table 41 reflect the factors discussed above. For example, a large proportion of corn waste is handled dry and seafood wastes are often disposed of in ways that do not require screening.

Residuals Holding Facilities. The survey questionnaires specified the methods of accumulating and ‘‘storing’’ solid residuals prior to hauling from the plant, tabulated as percentages of facilities (Table 42).

Moveable containers were the commonest facilities for accumulating solid residuals, followed by permanent hoppers. Relatively few plants, fairly well scattered by region and product, used stock piles. All Alaska plants used moveable containers and the percentage using hoppers was high in South West, North West and Mountain plants. Trucks were commonest in New England and least common in the western regions. Differences in these facilities were not very great among product classes except for seafood.

TABLE 42
ON-SITE RESIDUALS HOLDING FACILITIES

On-Site Holding Facility	New Eng.	Mid Atl.	South Atl.	North Cent.	South Cent.	Mount-ain	North West	Alas-ka	South West	Total
Stockpiles	8	4	9	8	7	4	4	0	1	5
Bins, barrels, etc.	38	44	49	37	37	30	45	100	46	42
Perm. hopper	8	29	25	31	26	43	43	0	46	36
Trucks	46	23	23	24	30	22	8	0	8	16

	Fruit	Tomato	Vegetable	Seafood	Specialty
Stockpiles	3	4	5	13	5
Bins, barrels, etc.	47	36	38	63	50
Perm. hopper	39	49	38	0	27
Trucks	11	10	20	23	18

The facilities used to accumulate solid residuals were associated with plant size, as shown in Table 43 (percentages of facilities).

TABLE 43
HOLDING FACILITIES AND PLANT SIZE

On-Site Holding Facility	Plant size, 1000 raw tons/year					
	0-1	1-5	5-25	25-100	100-200	Over 200
Stock piles	5	5	5	6	5	7
Bins, barrels, etc.	64	49	38	40	38	40
Perm. hoppers	5	22	38	40	38	53
Trucks	27	24	18	15	20	0

Stock piling did not vary with plant size, but the use of moveable containers and trucks decreased and the use of hoppers increased with increasing plant size.

On-Site Problems.

Introduction. The survey included information on problems with on-site solid residuals storage facilities. Such ''storage'' is necessarily short term because of the nature of the materials, but some system of accumulating the residuals for use or disposal is a necessity. Data were gathered on leaching (that is, separation of liquid from solid material during storage), seeping of liquid from the storage facility, insect problems and controls, rodent problems and controls, and odor problems. Some responses were ambiguous; for example, a missing response in the questionnaire could mean that there was no problem or that the existence of a problem was unknown. In addition, problems were recorded as occurring frequently, occasionally or never without strictly defining the first two terms. Indices of frequency have therefore been calculated from the percentage of plants giving particular answers, omitting ambiguous questionnaires completely, and giving double weight to frequent as compared to occasional problems. For example, 50% of the New England plants did not respond to the question on leaching problems; 14% reported frequent and 7%, occasional problems; and 28% reported never having the problem. The index was therefore calculated as 2(14) plus 7, which equals 35. Indices for the frequency of control programs were calculated in the same way. The indices permit comparisons among problems, regions, types of products, and processes, but are not to be interpreted as the percentages of plants with the given problems or control programs. The omitted, ambiguous questionnaires were about one out of six for the problems with leaching, seeping, etc., and about one out of four for the occurrence of insect and rodent control programs.

Problems. Odor, leaching, and seeping problems were much less common overall than insect problems, and rodent problems were in between; but the order of frequency of problems varied widely among regions and somewhat among product classes and processes (Table 44). Most striking of the regional differences was the almost complete absence of on-site problems in Alaska (associated with the efficient means of disposal practiced there). The most frequent leaching and seeping problems were encountered in New England, followed by the North West. North West, South Central and South Atlantic plants had the commonest insect problems; the North West, South Atlantic, and Mid Atlantic the commonest rodent problems. After Alaska, New England plants had the fewest of these two problems. Odor problems were commonest in the Mid Atlantic and least common in South Central, South West and Alaska plants.

Seafood plants had fewer than average problems in every category and tomato plants the same except for an average number of odor problems. Specialty and vegetable plants had above average problems throughout, in some instances by only a small margin. Freezers had higher problem indices than canners in all categories, and plants that both froze and canned were generally in between. Dehydraters had the expected low indices for leaching and seeping, but more frequent insect and rodent problems than plants using other processes.

These in-plant problems were not consistently related to plant size.

Control Programs. Control programs for insects were almost twice as frequent as insect problems and control programs for rodents were three times as frequent as rodent problems, on the average (Table 44). The control indices were greater than the problem indices in every comparison (except for zero problem, zero control, Alaska insects). The plants in the various regions and product and process classes tended to apply more frequent control programs where their problems were greater. The principal departures from this correlation were the extra frequent rodent control programs in the South West and in tomato and specialty plants. Control programs were slightly more frequent in larger than in smaller plants.

TABLE 44
FREQUENCY INDICES OF ON-SITE PROBLEMS AND CONTROL PROGRAMS

Problem	New Eng.	Mid Atl.	South Atl.	North Cent.	South Cent.	Mountain	North West	Alaska	South West	Total
Leaching	35	20	23	25	21	18	42	0	17	24
Seeping	56	18	29	22	16	9	30	0	19	22
Insect	21	56	70	62	74	54	81	0	52	59
Rodent	21	44	52	35	32	27	56	0	26	35
Odor	14	38	23	27	16	9	28	10	9	20
Control Programs										
Insect	49	116	136	119	110	99	111	0	108	107
Rodent	56	117	124	107	111	81	122	5	118	107

Problem	Fruit	Tomato	Vegetable	Seafood	Specialty	Can Only	Can & Freeze	Freeze Only	Any Dehdr.
Leaching	33	14	29	14	30	20	22	40	12
Seeping	23	16	23	29	25	20	18	37	6
Insect	67	53	70	31	79	55	49	73	81
Rodent	44	20	38	23	42	33	34	38	59
Odor	18	20	27	17	23	18	23	26	18
Control Programs									
Insect	103	121	111	51	154	100	77	129	125
Rodent	117	124	108	43	156	101	85	128	131

Holding Facilities. The occurrence of on-site problems was strongly related to the type of accumulation and holding facility used, as shown in Table 45 (problem frequency indices as described previously).

In almost all cases, the problem frequency index decreased from left to right in the table.

TABLE 45
HOLDING FACILITIES AND PROBLEMS

Problem	Stock Piles	Bins, Barrels	Hoppers	Trucks
Leaching	37	37	31	23
Seeping	27	31	27	26
Insect	94	77	68	57
Rodent	59	48	39	32
Odor	36	24	20	23

Disposal Methods

On-site Burning. The percentages of plants that burned (non-food) residuals at the plant site are listed in Table 46. (In addition, some materials were burned at disposal sites off the plant premises; data on these operations are given elsewhere in this report.) On-site burning was in open fires or in furnaces (or incinerators); and was classified in frequency as less than or more than once per day.

TABLE 46
ON-SITE BURNING

Type of Burning	New Eng.	Mid Atl.	South Atl.	North Cent.	South Cent.	Mountain	North West	Alaska	South West	Total
None	92	78	70	69	72	80	78	75	73	74
Open,										
1-/day	8	12	9	10	6	10	13	5	12	11
1+/day	0	2	9	9	0	0	5	20	1	5
Furnace,										
1-/day	0	0	6	3	0	0	5	0	7	4
1+/day	0	7	6	8	22	10	0	0	7	6

	Fruit	Tomato	Vegetable	Seafood	Specialty	Can Only	Can & Freeze	Freeze Only	Any Dehdr.
None	74	72	75	82	65	73	72	85	41
Open,									
1-/day	11	10	12	7	8	11	15	4	29
1+/day	5	10	4	9	1	6	8	4	6
Furnace,									
1-/day	6	5	3	0	4	5	0	2	6
1+/day	2	3	6	2	21	6	5	6	18

About three-fourths of the plants did not burn at all. Among those that did, periodic burning in open fires was the commonest method. A significantly high proportion of dehydrating plants and a significantly low proportion of freezing plants used on-site burning.

Solid Residuals Disposal Sites. Data on the size, location and operation of disposal sites for food processing solid residuals were given in the survey questionnaire. Most of the tabulated information that follows is in percentages that add to 100% of the sites for which data were reported. The columns in the table on materials handled at fill sites (processor waste only, garbage, etc.) add to more than 100% because many sites handled two or more types of material. Both food and non-food processor wastes are included in the following tables.

The survey questionnaires over-represented the largest plants and under-represented the smallest plants in the industry. The plant size bias affected some of the disposal site data; no adjustments for plant size effects have been applied in this part of the report.

Number and Type of Sites. The numbers of the different types of disposal sites reported in the questionnaires are in Table 47. Only incomplete data were recorded for some of these sites. The same site could have been reported by more than one processor and the same site may be listed more than once in the products table because some plants packed two or more products. Also listed is the average number of sites of each kind per plant; for example, in New England about 0.4 fill sites, 0 spread sites, and 0.1 burn sites were reported per plant in the survey sample.

More than one-fourth of the smallest plants but only 5% of the medium and large plants reported that they used no solid waste disposal site of any type. Otherwise, plant size was not significantly associated with the number of fill, spread, or burn disposal sites.

Location and Size. The distance from the processing plant and the number of acres occupied by the site are in Table 48 (percentages of reported sites). The acreage of burn disposal sites was not separately tallied.

The data on disposal sites that burned some materials were too sparse to show significant differences among regions or products; they averaged fewer miles from the processing plant than did all disposal sites.

Spread disposal sites averaged slightly closer to the processing plant than did fill sites. South West plants had significantly longer hauls than average to both fill and spread sites. Differences in hauling distances were greater among regions than among product classes.

TABLE 47
NUMBER AND TYPE OF DISPOSAL SITES

Type	New Eng.	Mid Atl.	South Atl.	North Cent.	South Cent.	Mountain	North West	Alaska	South West	Total
	Number of disposal sites in the survey									
Fill	5	29	27	80	11	6	52	4	73	287
Spread	0	20	12	56	4	3	10	3	33	141
Burn	2	3	10	12	2	2	8	3	18	60
	Average number of disposal sites per plant									
Fill	.4	.6	.8	.7	.6	.6	.7	.2	.8	.7
Spread	0	.5	.3	.5	.2	.3	.1	.1	.4	.3
Burn	.1	.1	.3	.1	.1	.2	.1	.1	.2	.1

	Fruit	Tomato	Vegetable	Seafood	Specialty
	Number of disposal sites in the survey				
Fill	100	49	147	12	60
Spread	42	28	92	9	13
Burn	16	9	27	4	17
	Average number of disposal sites per plant				
Fill	.7	.7	.6	.2	.8
Spread	.3	.4	.4	.2	.2
Burn	.1	.1	.1	.1	.2

TABLE 48
LOCATION AND SIZE OF DISPOSAL SITES

			New Eng.	Mid Atl.	South Atl.	North Cent.	South Cent.	Mount-ain	North West	Alas-ka	South West	Total
Miles to Site	Fill	1-	0	14	11	20	0	17	12	0	3	11
		1-9	100	72	70	70	82	83	76	100	59	70
		10+	0	14	18	10	18	0	12	0	38	18
	Spread	1-	--	35	17	17	25	33	10	0	0	15
		1-9	--	60	83	78	75	67	50	100	52	68
		10+	--	5	0	5	0	0	40	0	48	17
	Burn	1-	0	33	70	42	50	50	38	0	38	41
		1-9	100	67	30	50	50	50	62	100	44	52
		10+	0	0	0	8	0	0	0	0	19	7
Acres at Site	Fill	10-	25	28	75	20	11	20	29	50	5	23
		10-99	75	52	19	61	55	80	50	50	44	51
		100+	0	20	6	19	33	0	21	0	51	26
	Spread	10-	--	18	27	8	0	0	11	100	11	14
		10-99	--	65	55	51	100	100	44	0	44	52
		100+	--	18	18	41	0	0	44	0	44	34

			Fruit	Tomato	Vegetable	Seafood	Specialty
Miles to Site	Fill	1-	12	12	15	0	7
		1-9	68	63	71	92	77
		10+	20	24	14	8	17
	Spread	1-	7	18	13	11	23
		1-9	60	61	68	78	46
		10+	33	21	28	11	31
	Burn	1-	33	44	44	0	47
		1-9	53	44	48	100	47
		10+	13	11	7	0	6
Acres at Site	Fill	10-	25	16	25	12	20
		10-99	44	45	53	62	61
		100+	31	39	23	25	20
	Spread	10-	11	19	7	50	22
		10-99	43	42	57	25	33
		100+	46	38	26	25	44

Spread sites (which were usually agricultural land) averaged larger than fill sites. Greater variation in disposal site size occurred among regions than among product classes. South West fill sites were significantly larger and South Atlantic fill sites were significantly smaller than average.

Ownership and Materials Handled. The type of ownership (or operation) and the materials handled at disposal sites are in Table 49 (percentages of sites).

Under materials handled (at the disposal site), garbage, industrial refuse and domestic refuse are in addition to processor residuals, and two or more of these materials may be handled at the same time. Spread sites generally are not used for these materials.

More than half of the fill disposal sites were publicly operated, but those at which materials were burned had a comparable proportion of processor and public ownership. Spread sites were largely on private land and few were publicly operated. Processor operation of fill sites was significantly high for Mid Atlantic plants; and private operation for tomato plants. Most of the other very high and very low percentages in the table were based on few records and were not significantly different from average. High private operation of South West fill sites approached significance.

Less than one-fifth of the fill sites handled processor refuse only and most of the rest handled more than one of the other materials. Sites that burned material were more likely to handle processor residuals only, in this case largely non-food wastes. Percentages significantly different from fill site averages were--high percentages: processor residuals only in the Mid Atlantic, garbage in the North West and for seafood and specialty plants, and industrial refuse in the South West; low percentages: garbage in the Mid Atlantic and for tomato plants.

The ownership-operation and (at fill sites) the materials handled varied with plant size. At fill sites company and possibly private ownership increased and public ownership decreased with increasing plant size. These relationships were erratic at spread sites, but private ownership increased and public ownership decreased drastically with increasing plant size at burn disposal sites. The percentage of fill disposal sites that handled only the processing plant's waste increased from 0% for the smallest plants to 24% for the largest; the declines in percentages across the range of plant sizes for sites also handling garbage were 62 to 40%; also handling domestic refuse, 54 to 36%; and also handling industrial refuse, no marked trend.

Type of Land. Percentages of disposal sites on different kinds of land are in Table 50.

The high proportion of spread disposal sites on agricultural land is expected. As with many other disposal site characteristics, land types varied more among regions than among product classes. Percentages significantly different from average were (fill sites): high percentages, gully sites for North West and seafood plants; and level sites for Mid Atlantic plants; low percentages, gully sites for Mid Atlantic and North Central plants; and level sites for North West plants; (spread sites): a low percentage of agricultural and a high percentage of ''other'' sites for seafood plants. Data were too few to show significance in many of the apparently high or low percentages.

TABLE 49
OWNERSHIP OF AND MATERIALS HANDLED AT DISPOSAL SITES

	Owned, Operated by:	New Eng.	Mid Atl.	South Atl.	North Cent.	South Cent.	Mountain	North West	Alaska	South West	Total
Fill	processor	0	38	19	18	0	17	15	0	7	15
	private co.	20	28	23	38	18	0	21	0	42	31
	public	80	34	58	44	82	83	64	100	51	53
Spread	processor	--	38	50	25	25	33	18	67	22	29
	private co.	--	52	42	75	75	67	82	0	56	63
	public	--	10	8	0	0	0	0	33	22	8
Burn	processor	0	33	70	42	50	50	38	67	39	45
	private co.	0	0	10	25	0	0	0	0	17	12
	public	100	67	20	33	50	50	62	33	44	43
	Materials handled										
Fill	processor only	0	41	11	27	0	33	13	0	8	18
	garbage	60	31	44	58	73	17	69	100	51	54
	ind.refuse	60	41	41	55	55	67	44	50	66	53
	dom.refuse	80	34	37	51	45	50	31	50	45	43
Burn	processor only	0	33	60	42	50	50	25	0	39	38
	garbage	0	0	30	50	0	0	62	100	39	40
	ind.refuse	50	67	30	67	50	0	75	0	50	50
	dom.refuse	50	0	0	42	0	0	12	100	33	27

	Owned, Operated by:	Fruit	Tomato	Vegetable	Seafood	Specialty
Fill	processor	18	23	19	0	12
	private co.	32	46	28	17	35
	public	50	31	53	83	53
Spread	processor	20	24	25	33	54
	private co.	57	69	71	33	46
	public	23	7	4	33	0
Burn	processor	31	56	44	50	47
	private co.	12	22	2	0	24
	public	56	22	48	50	29
	Materials handled					
Fill	processor only	20	27	24	0	10
	garbage	48	31	56	92	70
	ind.refuse	48	59	53	50	63
	dom.refuse	38	43	42	42	53
Burn	processor only	25	44	44	0	47
	garbage	38	11	44	75	35
	ind.refuse	56	33	44	25	47
	dom.refuse	29	22	18	75	29

TABLE 50
TYPES OF LAND FOR DISPOSAL SITES

Type of Land	New Eng.	Mid Atl.	South Atl.	North Cent.	South Cent.	Mount-ain	North West	Alas-ka	South West	Total
Fill Sites										
Pit	60	8	30	25	20	17	17	0	11	19
Gully	20	12	25	20	30	50	56	100	33	32
Level	20	62	40	39	50	33	21	0	36	37
Marsh, tidal	0	8	5	12	0	0	4	0	20	11
Other	0	8	0	4	0	0	2	0	0	3
Spread Sites										
Agricultural	--	76	80	91	75	100	73	0	76	83
Waste	--	12	10	9	25	0	18	0	19	13
Other	--	12	10	0	0	0	9	100	5	4

	Fruit	Tomato	Vegetable	Seafood	Specialty
Fill Sites					
Pit	15	19	18	10	23
Gully	34	19	30	70	36
Level	38	49	38	20	30
Marsh, tidal	13	13	9	0	10
Other	0	0	5	0	2
Spread Sites					
Agricultural	79	86	80	40	75
Waste	14	0	16	0	25
Other	7	14	3	60	0

Delivery and Covering Frequency. The number of deliveries per day to disposal sites and the number of coverings per day of materials at the site were reported in Table 51 (percentages of sites). The frequency “1-”, meaning less than once per day, ranged from about once every two days to a few times per season.

Differences in the frequency of hauling to disposal sites and of coverings at the sites were much greater among regions than among product classes, although seafood plants tended to be different from other product plants. Only a few data were reported for some regions. Deliveries to spread sites were much more frequent on the average then deliveries to fill sites; this was expected because in many spread disposal operations growers take trimmed leaves and other residuals on return trips from delivering raw product. Only small percentages of fill disposal sites were never covered or were covered only occasionally, and the average frequency of coverings was much greater at fill than at spread sites. The latter contrast was also expected because of the nature of typical fill and spread operations.

TABLE 51
DELIVERY AND COVERING FREQUENCY AT DISPOSAL SITES

Number per day	New Eng.	Mid Atl.	South Atl.	North Cent.	South Cent.	Mountain	North West	Alaska	South West	Total
Deliveries to fill sites										
1-	0	16	5	6	22	0	14	0	13	11
1	80	8	45	24	33	20	40	100	31	31
2-4	20	28	25	40	33	60	24	0	23	29
5+	0	48	25	30	11	20	21	0	34	29
Coverings at fill sites										
Not covered	0	0	5	7	0	0	3	0	6	4
1/season	0	12	5	3	0	0	11	0	5	6
1-	0	25	24	16	0	17	25	100	5	16
1	100	50	57	64	80	83	53	0	67	62
2+	0	12	10	10	20	0	8	0	17	12
Deliveries to spread sites										
1-	--	5	0	4	0	33	0	100	3	6
1	--	11	8	13	0	67	67	0	7	15
2-4	--	16	42	33	33	0	0	0	27	26
5+	--	68	50	51	67	0	33	0	63	53
Coverings at spread sites										
Not covered	--	43	0	26	67	0	14	0	17	23
1/season	--	21	18	22	0	0	43	0	17	20
1-	--	14	36	20	0	50	14	100	17	22
1	--	21	27	26	0	50	29	0	42	28
2+	--	0	18	6	33	0	0	0	8	7

Number per day	Fruit	Tomato	Vegetable	Seafood	Specialty
Deliveries to fill sites					
1-	13	10	9	33	9
1	26	12	28	45	33
2-4	30	17	32	11	33
5+	31	62	30	0	24
Coverings at fill sites					
Not covered	5	5	4	0	4
1/season	8	8	5	0	0
1-	14	12	16	43	10
1	60	62	60	57	73
2+	13	12	15	0	14
Deliveries to spread sites					
1-	0	11	2	38	0
1	11	7	17	38	30
2-4	25	21	27	25	40
5+	64	61	54	0	30
Coverings at spread sites					
Not covered	15	28	21	12	50
1/season	21	24	21	12	0
1-	12	12	20	62	10
1	30	32	31	12	40
2+	21	4	6	0	0

Significantly different frequencies were (fill sites): high frequency of deliveries from Mid Atlantic, North Central and tomato plants; low frequency of deliveries from seafood plants; high frequency of covering for specialty plants, and low frequency for Alaska plants; (spread sites): low frequency of deliveries from North West, Alaska and seafood plants; high frequency of covering for fruit plants. The covering frequencies at spread sites for Alaska and for seafood plants were almost significantly low.

Disposal Site Problems.

Introduction. Data on a number of characteristics of solid waste disposal sites are summarized and discussed above. The relationships between some of these characteristics and problems with insects, rodents, odors and water pollution are considered here. Disposal by spreading on land, by filling and by burning are treated separately. Most of the spread disposal sites were on agricultural land. Disposal by ''filling'' included simple dumping as well as more or less careful covering and compacting. Some materials were burned at some sites. The problems considered in this section of the report include those stemming from non-food as well as food residuals from processing plants.

Only the presence or absence of a problem was indicated on the questionnaires, and not its frequency or severity. As for on-site problems, some of the questionnaires were ambiguous with respect to disposal site problems; a blank could have meant either no problem or problem unknown. The analyses were based on the percentage of plants indicating some problem out of the total number that recorded or implied some specific response. Questionnaires with the pertinent section totally blank were omitted, including those from plants that had no solid waste disposal site and, therefore, no problems. The percentages are evidently higher than they would be with complete knowledge and should be thought of as indices, somewhat like the ones calculated for on-site problems. An index was considered significant if it differed from the overall index for the problem with approximately 95% confidence.

As elsewhere in this report, the product headings (fruit, tomato, etc.) do not mean that the plant packed that product only, but merely that it packed that product and perhaps others.

Fill Site Problems. Indices to fill disposal site problems and the numbers of reported fill sites are in Table 52.

Problems with water pollution from fill disposal sites were seldom reported and are omitted from further analysis. Three plants wrote in air pollution (unspecified) as a problem at these sites, too few for any conclusions. However, odor is an air pollutant. ''Non-food'' means sites that disposed of non-food wastes (paper, wood, etc.) from processors; disposal sites under the other headings may also have handled non-food wastes.

TABLE 52
FILL DISPOSAL SITE PROBLEMS

Problem	New Eng.	Mid Atl.	South Atl.	North Cent.	South Cent.	Mount-ain	North West	Alas-ka	South West	Total
Insect	25	72	82	54	100	100	35	50	53	58
Rodent	100	44	88	46	75	67	56	100	44	55
Odor	50	67	47	49	88	33	46	50	37	49
Water	0	6	0	6	0	0	8	50	5	6
No. of fill sites	5	29	27	80	11	6	52	4	73	287

	Fruit	Tomato	Vege-table	Sea-food	Specialty	Non-Food
Insect	57	71	47	43	65	55
Rodent	54	32	45	86	78	62
Odor	45	42	51	57	57	50
Water	7	6	2	17	8	--
No. of fill sites	100	49	147	12	60	153

A substantial number of fill disposal site problems of at least one kind were reported by every region and product class. Problems were generally more variable among regions than among products. Records were available from only a few sites in some of the regions, decreasing the precision of the indices to a low level. The prevalence of fill site problems in the different regions and product classes (Table 52) did not correlate with the prevalence of the same problems at the factory site (Table 45). For example, Alaska and New England reported high indices of rodent problems at fill sites, but the fewest rodent problems of all regions at the plant site. (None of the four Alaska fill sites handled any food wastes, but only non-food materials.) Significantly high problem indices at fill sites (Table 52) were: insect problems, South Atlantic and South Central; rodent problems, South Atlantic, specialties and non-food; and odor problems, Mid Atlantic and South Central. Significantly low indices were: insect problems, North West and vegetables; rodent problems, tomatoes and vegetables; and odor problems, South West. The only consistent relationship to plant size was the high proportion of problems with insects, rodents and odors at sites used by plants in the smallest size category.

Spread Site Problems. Indices to spread disposal site problems and the number of reported spread sites are in Table 53.

As for fill sites, sparse data made the percentage figures on spread site problems in some regions insignificant; details on the three Mountain spread sites were lacking.

TABLE 53
SPREAD DISPOSAL SITE PROBLEMS

Problem	New Eng.	Mid Atl.	South Atl.	North Cent.	South Cent.	Mount-ain	North West	Alas-ka	South West	Total
Insect	--	47	50	21	100	--	14	0	86	42
Rodent	--	21	20	5	0	--	14	0	32	15
Odor	--	60	60	40	100	--	57	100	52	52
Water	--	0	0	2	0	--	0	0	0	1
No. of spread sites	0	20	12	56	4	3	10	3	33	141

	Fruit	Tomato	Vege-table	Sea-food	Specialty	Non-Food
Insect	63	52	37	22	30	62
Rodent	30	14	10	33	12	46
Odor	52	43	48	67	44	69
Water	0	0	1	11	0	--
No. of spread sites	42	28	92	9	13	13

Except for odors, which averaged slightly more, problems at spread sites were less common than at fill sites; a clear-cut exception was the greater percentage of insect problems at spread than at fill sites in the South West. Significantly high problem indices at spread sites were: insects, South West and fruit; rodents and odors, non-food. A significantly low index was for insects, North Central. Rodent problem indices approached significance for South West and fruit plants (high) and for North Central and vegetable plants (low). Non-food sites had substantially higher indices than average for three of the problems (water problems at non-food sites were not analyzed).

At spread disposal sites, insect problems increased in frequency with increasing plant size; rodent and odor problem indices were not associated with plant size.

Burn Site Problems. Disposal sites where some of the materials were burned (often at the plant and sometimes at fill or spread disposal sites) were analyzed in less detail. Percentage indices are in Table 54.

The number of burn sites listed is generally not the number from which data were tallied; some of the sites were recorded as in use but no data on problems were given. The number of samples in each column is too small to show significance in any of the individual indices, although the insect problem index for fruit plants is almost significantly high. Overall, insect and rodent problems apparently were less frequent and odor problems were more frequent at sites that burned than at fill sites.

TABLE 54
BURN DISPOSAL SITE PROBLEMS

Problem	New Eng.	Mid Atl.	South Atl.	North Cent.	South Cent.	Mount-ain	North West	Alas-ka	South West	Total
Insect	--	0	71	36	50	100	50	0	40	44
Rodent	--	100	57	55	0	100	33	0	40	44
Odor	--	100	71	55	50	100	50	100	50	61
Water	--	0	0	18	0	0	17	0	0	7
No. of burn sites	2	3	10	12	2	2	8	3	18	60

	Fruit	Tomato	Vegetable	Seafood	Specialty
Insect	70	50	29	25	46
Rodent	60	50	38	0	54
Odor	60	50	47	100	67
Water	10	0	18	0	0
No. of burn sites	16	9	27	4	17

The insect and rodent problem indices varied erratically among plant size categories, but odor problems decreased signficantly and consistently with increasing plant size.

Disposal Site Operations. Differences were found among disposal sites operated by food processors, by private companies, and by public agencies (Table 55, frequency indices).

TABLE 55
DISPOSAL SITE OWNERSHIP AND PROBLEMS

	Fill Sites			Spread Sites		
	Operated by:					
Problem	Processor	Private	Public	Processor	Private	Public
Insect	50	50	55	46	44	55
Rodent	41	40	70	23	17	44
Odor	33	38	63	63	42	75

Significantly high indices were those for rodents and odors at publicly operated fill and spread sites. Significantly low indices were: rodents, privately operated fill sites; and odors, processor and privately operated fill sites. (Significance was estimated separately for fill site and spread site data. As elsewhere, differences from the overall average were used in judging significance, taking into account the numbers of items entering into each percentage or index.)

Fill disposal sites were often used for garbage and/or industrial and domestic refuse in addition to solid residuals from food processors. The percentage indices of problems at fill sites handling these classes of materials are in Table 56.

TABLE 56
MATERIALS HANDLED AND PROBLEMS

	Materials Handled at Fill Site		
Problem	Processors Only	Include Garbage	Include Refuse
Insect	58	51	52
Rodent	28	66	58
Odor	36	58	50

A significantly high index was that for rodents at sites handling garbage; significantly low indices were for rodents and odors at sites handling processor residuals only.

Problems were tallied separately for spread disposal on agricultural and on non-agricultural land. Insect problems were practically the same at both, but rodent and odor problems were much more prevalent in non-agricultural sites. Indices were: insects, 46 and 45%; rodents, 17 and 30%; odors, 41 and 67%, on agricultural and non-agricultural land, respectively.

Information was sought but not always recorded on the frequency of covering the materials at fill and at spread disposal sites. Problem indices are in Table 57.

TABLE 57
COVERING FREQUENCY AND PROBLEMS

	Fill Sites					Spread Sites				
	Covering frequency, per day:									
Problem	O & Seas	1-	1	2+	?	O & Seas	1-	1	2+	?
Insect	77	62	48	71	33	51	42	53	33	34
Rodent	74	55	52	66	54	13	29	23	11	31
Odor	69	55	51	56	28	55	71	37	78	34

''O & Seas'', means no covering or only about once a year; ''1-'', ''1'' and ''2+'' mean less than once, once, and two or more times per day, respectively; and ‘‘?’’ means frequency of covering unknown. No clear relationships were shown in Table 57. The least frequently covered fill sites had the maximum indices (all three significantly high), but those for the most frequently covered fill sites were also high (significantly for insects and rodents), and relationships were even more mixed at spread sites.

By-product Outlets. The percentages of plants in the survey with various outlets for by-products are in Table 58. ‘‘Feed’’ in the table means animal feed but includes some very small quantities of human food by-products (apricot seeds, for example). ‘‘Fertilizer’’ includes soil conditioners. ‘‘Non-food’’ means the recovery of non-food wastes such as metal, cardboard and paper. ‘‘Other’’ includes a few miscellaneous uses (cosmetics and abrasives, for example) and some unclassified by-products. ‘‘None’’ includes unknown.

TABLE 58
BY-PRODUCT OUTLETS

By-product use	New Eng.	Mid Atl.	South Atl.	North Cent.	South Cent.	Mountain	North West	Alaska	South West	Total
Feed	21	26	50	55	42	73	80	9	54	52
Charcoal	0	0	0	1	0	0	0	0	16	4
Alcohol	0	0	0	0	0	0	4	0	9	3
Vinegar	0	5	0	4	0	0	3	0	0	2
Oil	0	0	3	0	0	0	1	9	10	3
Fertilizer	29	0	0	2	0	0	3	0	3	3
Non-food	0	5	3	8	11	0	4	0	14	7
Other	7	7	11	2	16	0	8	18	7	7
None	43	63	39	38	47	27	14	77	26	36

	Fruit	Tomato	Vegetable	Seafood	Specialty	Can Only	Can & Freeze	Freeze Only	Any Dehdr.
Feed	51	29	64	23	43	46	44	73	65
Charcoal	10	9	2	0	1	6	2	0	0
Alcohol	8	4	3	0	1	3	2	0	6
Vinegar	5	1	2	0	1	2	0	2	0
Oil	7	3	1	8	0	3	4	1	0
Fertilizer	1	0	1	9	3	2	5	2	0
Non-food	8	9	5	0	17	8	4	6	0
Other	7	4	3	17	13	5	2	9	6
None	27	54	22	57	40	38	42	19	29

The columns may add to more than 100% because some plants had two or more by-product outlets.

More than a third of the plants did not report a by-products use and just over half reported use as feed. The percentages of feed use were significantly higher than average for North West, vegetable, and freeze only plants; and were significantly lower for New England, Mid Atlantic, Alaska, tomato, seafood, and can only plants. South West and fruit plants had significantly high percentages of outlets other than feed; North Central and vegetable plants, significantly low percentages.

The proportions of plants with by-products are greater in the survey sample than they would be in the industry as a whole as shown by the survey bias toward larger plants and the data in the following:

Plant size, 1000 raw tons/year	0-1	1-5	5-25	25-100	100-200	Over 200
% of plants with by-products	16	49	57	87	77	73

Correcting the plant size bias by the rough approximations of the true number of plants in each size category (which is developed elsewhere in this report) increased the percentage of plants with no by-product outlet from 36 to just over 50%. The precision of the bias-correcting approximations may not be very good. In any case, the sample plant size bias had much less effect (and possibly none) on the tons of residuals used as by-products because most of the tonnage is handled by larger plants.

Having a by-product outlet does not imply an income from the by-product. Some plants had net expenses in disposing of residuals as by-products and others broke even.

The tonnages of solid residuals used as by-products and by-product incomes are given in detail elsewhere in this report (see the section on ''Solid Residuals Quantitites'' and that immediately below).

Cost of Residuals Handling, Treatment and Disposal

Introduction. The questionnaire for the solid wastes survey requested information on the out-of-pocket costs for solid waste hauling and disposal sites and on income from by-products. These data were fairly complete and permitted a detailed summary by plant size and product type; plant-to-plant variation was very large. Extrapolation to the entire surveyed industry introduced errors from the estimates of the number of plants in each product and size class.

Data on other solid and liquid waste costs were secured during the site visits. Some of these figures were estimates made by the plant personnel. About 40% of them were incomplete, covering the costs of some but not all of the equipment and operations; the resulting summaries are therefore underestimates.

Plants were put into six classes according to the total tons of raw products received in a year (up to 1,000; 1-5,000; 5-25,000; 25-100,000; 100-200,000; and over 200,000). Five product classes were defined: fruit, tomato, vegetable, seafood and specialty. Data for plants that packed a combination of fruits, tomatoes, and vegetables were separately summarized and a contribution from this summary was assigned to each of the three specific product classes. A plant packing any specialty product was classified as a specialty plant, whether or not it also packed other items. Seafood plants generally did not pack items from the other product classes. The tonnage figures used to classify specialty plants by size were less precise than those for the other product classes; tonnages of preprocessed products for repacking were omitted where possible.

Haul Plus Site Costs. The average annual out-of-pocket costs per plant for solid waste hauling and disposal sites are in Table 59.

TABLE 59
AVERAGE HAUL PLUS SITE COSTS*

Product class	Plant size, 1000 tons per year 0-1	1-5	5-25	25-100	100-200	Over 200
fruit	.5	1.4	5.9	19.2	25.2	14.0
tomato	0	.8	6.4	17.8	23.1	46.1
vegetable	1.2	3.9	5.1	14.0	22.4	29.8
seafood	.7	.4	4.3	----	----	----
specialty	.7	3.4	12.2	24.9	24.0	65.4
All	.7	1.9	6.4	17.6	23.5	32.0

*x $1000

The averages in the table were based on figures from one to 59 plants in each product:size classification; half the averages were of six or more plants. Individual plant costs varied widely around the listed averages.

Economies of scale were shown in the haul plus site costs; the larger the plant, the lower the cost per ton of raw product. Rough estimates are:

Raw tons per plant	1,000	10,000	100,000
Average cost per raw ton	$1.0	$.5	$.2

Seafood plants and small tomato plants had lower costs than average. Specialty plants apparently had generally high costs, possibly a result of some misclassification in plant sizes.

Estimates of the surveyed industry's total haul plus site costs are given in a later section of this report (Table 62).

TABLE 60
HAUL PLUS SITE COSTS FOR FILL AND SPREAD DISPOSAL*

Type of Disposal	Plant size, 1000 tons per year 0-5	5-25	25-100	Over 100
Fill	1.9	9.3	15.3	35.6
Fill and Spread	3.9	5.6	18.7	25.0
Spread	1.1	5.0	21.6	15.0

*x $1000, per year

Table 60 lists average haul plus site costs per plant per year separating fill and spread disposal sites. The averages were based on figures from two to 54 plants in each disposal method:size classification; half the averages were of 22 or more plants. ''Fill and spread'' means that both disposal methods were used by the same plant. These out-of-pocket costs were generally greater for residuals going to fill than for those going to spread disposal sites.

By-product Incomes. Incomes from food by-products and those from non-food by-products were summarized separately (Table 61). Non-food by-products are metal, paper, and the like salvaged from the processing operations. Much of the non-food by-products income was from scrap produced in can manufacturing plants run in conjunction with canneries; unfortunately, this source could not be consistently identified for elimination and all such figures were therefore included. Among other income sources were emptied cans used as nursery planters and cardboard and paper use for re-manufacture. By far, the largest food by-product was animal feed from peels, husks, culls, and other discarded materials. Large differences were reported among plants in by-products income per ton.

Some plants with by-products failed to report whether or not they realized an income from them; these plants were omitted entirely from the summaries. Otherwise the averages in Table 61 are across all plants, including those with a by-product and an income, a by-product but zero income, and no by-product. They therefore estimate average by-product incomes per plant for all the surveyed industry by plant size and product class.

The averages in the table were based on figures from one to 41 plants per product:size classification; half the averages were of seven or more plants. The smaller plants are all assumed to have no non-food by-products income; positive data were often lacking.

TABLE 61
AVERAGE BY-PRODUCT INCOMES*

	Plant size, 1000 tons per year					
	0-1	1-5	5-25	25-100	100-200	Over 200
Product Class	Food by-products					
fruit	0	1.0	2.8	9.5	27.	.6
tomato	0	.3	2.4	3.4	0	.3
vegetable	0	.3	3.6	16.	27.	96.
seafood	0	3.5	6.7	---	---	---
specialty	.5	7.3	8.9	30.	200.	24.
All	.1	2.2	4.3	18.	36.	31.
	Non-food by-products					
fruit	-	-	.8	2.6	-	-
tomato	-	-	1.4	.5	-	.3
vegetable	-	-	.4	.2	-	-
seafood	-	-	---	---	-	-
specialty	-	-	.2	41.	130.	72.
All	-	-	.6	10.	14.	15.

*x $1000, per year

Specialty plants had the highest and tomato plants the lowest by-product incomes. Seafood plants that had any by-product outlet at all had relatively high incomes per ton, as expected. The declines in dollars per plant for the largest plants were probably accidents of sampling; relatively few data were available in these size classes. Small plants had practically no by-products income. Some plants with by-products realized no income from them. Extrapolations to the entire surveyed industry are estimated below.

Total Industry Haul Plus Site Costs and By-Product Incomes. Extension of the per plant average data to total industry costs and incomes required estimates of the number of plants in each size and product class. These estimates were made on the following bases:

a) The U.S. Census of Manufactures total of about 2800 plants in the surveyed industry.

b) The proportion of plants in each size and product class according to the survey questionnaires.

c) Census of Manufactures data giving about half of the plants with an average employment of 20 or less, and the assumption that such plants would process 5000 or fewer tons per year.

d) Adjustments to account for the total estimated raw tons processed per year in each product class.

The reliability of these estimated numbers of plants is not known, and they affect the extrapolations to total industry costs and incomes drastically. The latter should therefore be considered rough estimates.

TABLE 62
PLANT NUMBERS AND INDUSTRY TOTAL HAUL/SITE AND BY-PRODUCT INCOMES

	Plant size, 1000 tons per year						
Product class	0-1	1-5	5-25	25-100	100-200	Over 200	Total
	Estimated Number of Plants						
fruit	70	300	200	100	20	10	700
tomato	20	150	60	40	20	5	295
vegetable	100	600	350	50	10	5	1,115
seafood	130	150	10	10	0	0	300
specialty	200	130	30	20	5	5	390
Total	520	1,330	650	220	55	25	2,800
	Haul Plus Site Costs, $Million Per Year						
fruit	0	.4	1.2	1.9	.5	.1	4.2
tomato	0	.1	.4	.7	.5	.2	1.9
vegetable	.1	2.3	1.8	.7	.2	.2	5.3
seafood	.1	.1	0	0	-	-	.2
specialty	.1	.4	.4	.5	.1	.3	1.9
Total	.4	3.4	3.8	3.8	1.3	.8	13.5
	Food By-Product Income, $Million Per Year						
fruit	0	.3	.6	1.0	.5	0	2.4
tomato	0	0	.1	.1	0	0	.3
vegetable	0	.2	1.3	.8	.3	.5	3.0
seafood	0	.5	.1	0	-	-	.6
specialty	.1	1.0	.3	.6	1.0	.1	3.1
Total	.1	2.0	2.3	2.5	1.8	.6	9.3
	Non-Food By-Product Income, $Million Per Year						
fruit	-	-	.2	.3	-	-	.4
tomato	-	-	.1	-	-	-	.1
vegetable	-	-	.1	-	-	-	.2
seafood	-	-	-	-	-	-	0
specialty	-	-	-	.8	.6	.4	1.8
Total	-	-	.4	1.1	.6	.4	2.5

The figures in Table 62 were rounded after adding.

Total haul plus disposal site costs for solid wastes were estimated at $13.5 million and total by-product income at $11.8 million per year for the entire surveyed industry (Table 62). These estimates average about $.40 and $.35 per raw ton, respectively, with a very large range among individual plants.

Residuals Handling and Treatment Costs. The cost data on handling and treating solid and liquid wastes collected during the site visits were less extensive and less precise than those on solid waste haul plus site costs and on by-product incomes. Handling and treatment costs were therefore reduced to dollars per raw ton for the various operations, without distinctions among plant sizes and product classes in the first approximation. Capital costs were summarized for five types of operation: (1) in-plant liquid waste handling, including flumes, pipes, sumps, gutters, screens, and a few miscellaneous items; (s) in-plant solid residuals handling, including elevators, containers, hoppers, trucks, and miscellaneous items; (p) simple ponds, mostly holding ponds; (t) liquid treatment systems, including aerated and evaporation ponds, activated sludge systems, and trickling filters; and (i) irrigation systems, mostly spray irrigation. Average capital costs were brought up to date by an average factor of 1-1/6, estimated from the average age of the equipment, since installation dates were not always known. Annual costs of capital were taken to be 10% of capital costs.

Annual operation and maintenance costs and sewer charges were estimated as described below. The cost data represented plants with wide ranges in size, packing all products, and located in all regions of the United States.

Capital Costs. The average costs per raw ton of the individual systems were (before adjustment for year installed):

System	In-plant liquid(1)	In-plant solid(s)	Simple pond(p)	Treat-ment(t)	Irrig-ation(i)
No. of records averaged	26	33	4	8	13
Dollars/ton	.9	1.1	1.4	7.1	2.2

Also taken into account were capital costs of combined systems, as follows, using the system designations in the preceding list:

Systems	1+t	1+i	1+t+i	1+s	1+s+p	1+s+t	1+s+i	1+s+t+i	p+i
No. of records	4	3	1	29	2	1	3	2	2
Dollars/ton	7.4	1.8	10.0	1.1	2.8	3.2	15.6	2.7	6.1

The resulting weighted averages of all the capital costs, brought up to date by the 1-1/6 factor, were:

System	l	s	p	t	i
Dollars/ton	.9	1.2	1.6	6.0	4.2

About 40% of the capital cost estimates included only part of the equipment in use. No adjustment was made for the missing items, so the estimates are expected to be low.

Operation and Maintenance Costs. Annual operation and maintenance (O and M) costs were available for 28 of the liquid waste systems, 32 of the solid residuals systems, and 28 combined systems. The O and M cost per year averaged 7.2, 17.4 and 11.8%, respectively, of the capital costs of these systems. Some of the O and M estimates also were incomplete (labor costs were sometimes excluded, for example). Annual O and M costs were estimated to be 1/12 of capital costs for liquid systems and 1/6 of capital costs for solid residuals systems; the latter ratio was fairly consistently higher than the former in the individual plant records.

Sewer charges were available from 35 plants and they averaged $.40 per raw ton of product for those plants that had a sewer charge.

Combined Costs. Total liquid and solid waste costs per ton were averaged over the industry in accordance with the estimates that all plants had in-plant liquid and solid handling systems, 1/14 of the plants had simple ponds, 1/5 of the plants had liquid waste treatment systems, 1/5 of the plants had irrigation systems, and 56% of the plants had sewer charges (Table 63). These are the proportions of plants using the various systems recorded in the site visits of this study. Solid waste hauling and disposal site costs averaged over all plants were taken from a previous section of this report.

The estimated total cost of handling and treating liquid and solid wastes, $1.44 per raw ton, multiplied by the 33.5 million tons processed by the industry gives a total annual expenditure of about $50 million.

This estimate of total costs is expected to be low because of omissions of some items of cost in the original data, as explained above. Other uncertainties in the estimates could have influenced the total in either direction.

Costs by Plant Size. The cost data on handling and treating liquid and solid wastes collected during the site visits were also used to estimate the annual costs by plant size (but ignoring product class); see Table 64. These estimates are even less precise than the ones given above; they required considerable extrapolation and they have been rounded. The costs of simple ponds have been omitted entirely. The two smallest plant size classes have been combined. The extension to total costs for the industry was by the same estimated proportions of plants utilizing the various systems as above. As when estimating total haul plus site costs and by-product incomes from solid residuals, the estimated numbers of plants in the various size classes drastically affected the extension to total industry costs.

TABLE 63
INDUSTRY LIQUID AND SOLID RESIDUALS COST ESTIMATES*

	Unit capital	% of plants	Average capital	Annual capital	Annual O & M	Annual total
LIQUID WASTE						
in-plant	.90	100	.90	.09	.07	.16
simple ponds	1.60	7	.11	.01	.01	.02
treatment systems	6.00	20	1.20	.12	.09	.21
irrigation systems	4.20	20	.84	.08	.06	.14
sewer charges	.40	56	-	-	.22	.22
Total, liquid						.75
SOLID WASTE						
in-plant	1.20	100	1.20	.12	.17	.29
haul, site					.40	.40
Total, solid						.69
TOTAL LIQUID AND SOLID COSTS						1.44

*Dollars per ton of raw product.

The costs were derived from widely varying figures for individual plants. Some recorded costs were several times as great as the listed estimates; for example, a few hundred thousand dollars for some treatment systems. Data for the largest plants were especially sparse and their estimates are believed to be conservative.

Extension of the unit cost estimates in Table 64 to the whole surveyed industry resulted in the following total costs (reducing treatment and irrigation systems and city treatment by the proportions of plants that use these systems and utilizing the estimated number of plants in each size class), $million per year:

in-plant liquid waste handling	$ 9	
treatment systems	7	
irrigation systems	4	
city treatment	10	
total liquid waste		$30
in-plant solid residuals handling	14	
haul plus disposal site costs	14	
total solid residuals		27
industry total		$57

TABLE 64
ESTIMATED RESIDUALS COSTS BY PLANT SIZE*

	Plant size, 1000 tons per year				
System	0-5	5-25	25-100	100-200	Over 200
in-plant liquid waste	2	4	8	10	15
treatment system	5	25	30	35	40
irrigation system	5	10	15	20	20
city treatment	3	8	25	35	40
in-plant solid residuals	2	4	20	30	50
haul plus site	2	6	17	24	32

*x $1000, per year

Alternative Processes

Comparison to Residuals from Fresh Foods. Canning, freezing, and dehydrating permit the consumption of foods at any time of the year and therefore production on a large scale by efficient agricultural and fishing procedures. All of the foods processed by these methods except olives are also marketed in the fresh state. Processed and fresh products generate the same types of solid residuals but the sites of wastage and the total quantities wasted are different.

Agricultural wastes such as vines, leaves, tops, and prunings left in the field are the same for processed and for fresh foods and are not included in this survey.

Unsuitable product units such as those that are under- or over-mature, odd sized or shaped, or affected by mold, insects or other defects are somewhat the same in processing and in fresh marketing. Sorting culls from processing commodities takes place in part during harvest, for some products in part at intermediate ~~central~~ stations, and in any case at the processing plant. Culls may be removed from fresh marketed produce during harvest and in packing sheds, near the field or after transportation. Some kinds of culls considered unusable in the fresh market may be utilized in whole or in part for processing. For example, undersized or misshapen units are satisfactory for pureed or juiced products, and parts of units may be salvaged after trimming away defects. As a result, the percentage of residuals from cullage is expected to be less for processed than for fresh commodities.

Another source of solid residuals is spoilage between the points of harvest and consumption; for example, units may become moldy or may dehydrate. Some products (apple, pumpkin) are easily held without significant deterioration for either processing or fresh marketing; some require cold storage (pears). Many commodities, especially most vegetables, succulent fruit, meat, poultry, and seafoods, deteriorate rapidly. Less wastage results from the short time lag for processing than from the normal transportation and holding period for fresh marketing. Some waste occurs from abnormally long holding of fresh products without sale at a market or without consumption in a home. Such losses are uncommon at processing plants.

A significant difference between processed and fresh commodities is in the site of generation of residuals from inedible parts. Peels, husks, shells, seeds, pits, cobs, and the like are removed and accumulated at processing plants in concentrations that permit, in many cases, reuse as animal feed or other by-products, or at least disposal by relatively efficient methods. When these residuals are removed from fresh produce in homes or restaurants, they are generally too widely scattered and too much mixed with other debris for economic re-cycling. Specialized equipment may also produce less waste in their removal; for example, lye peeling generates less waste than knife peeling.

Losses of both processed and fresh foods occur from spillage, crushing and other accidents.

Processed foods reach the consumer in more durable containers than do fresh marketed foods: mostly metal, glass, and waxed cardboard for the former; mostly paper and plastic for the latter. In addition, processed food packages have paper (or less often, lithographed) labels. Cardboard cases commonly accompany processed foods as far as the retail outlet; cardboard, burlap, or wooden containers are used for fresh foods. Relatively small quantities of consumer packaging materials are collected for re-cycling from the widely scattered points of consumption, although a beginning has been made. Large quantities are disposed of with other domestic refuse.

Data on the quantities of solid residuals generated in fresh marketing could not be found to compare with the estimates for processed foods in this study. However, the Market Quality Research Division, Agricultural Research Service, U.S. Department of Agriculture, is studying such losses in the New York and Chicago regions; publication of their findings is expected early in 1972.

Relation of Solid Residuals to Water and Air Pollution. Food processing residuals, as previously described, are generally characterized by a high moisture content and are highly putrescible. These characteristics are primarily responsible for the inter-relation between these solid residuals and potential water and air pollution problems.

In-plant handling methods significantly influence the effect which solid residuals have on the organic load, as measured by the biochemical oxygen demand (BOD) and suspended solids content, contained in the processing wastewater. Most fruits and vegetables contain high concentrations of soluble solids. The degree to which these solubles are lost from both the commodity and the residuals derived therefrom is a function of the frequency with which these residuals come in contact with water and of the surface area of the material which is exposed to water contact. For example, hydraulically-conveyed pear and pear residuals contribute significantly to the organic load of the liquid waste, primarily through physical rinsing of exposed surfaces and through leaching due to osmosis. When either of these materials is immersed in water, both the BOD and suspended solids increase as a function of the duration of immersion. The cumulative result of repetitive immersions in batches of fresh water also reflect similar increases. Increases in both parameters are also related to particle size and, hence, to the exposed surface area. Small pear fragments result in a more significant contribution to the organic load than large pieces or whole pears. Thus, extensive use of hydraulic conveying systems, especially for particulated residuals, results in the generation of significantly higher strength liquid waste.

Surface and groundwater pollution problems can occur from dumping and landfilling of food residuals due to the high moisture contents of these materials. Compaction of these residuals stimulates the generation of leachate which increases the potential for water pollution. The problem of leachate is also associated with trench-and-cover operations. However, water pollution problems are eliminated or greatly minimized by well-conducted spread-and-disc operations, primarily due to the extensive evaporative loss of moisture from the soil surface.

The high putrescible nature of food residuals is the basis for the relation between these materials and potential air pollution problems. The anaerobic degradation of organic materials which take place in stockpiles and in landfill sites produces gases which are aesthetically disagreeable to most people. These gases are especially noticeable when stockpiles or landfill sites are opened after a period of time. Such odors, although not of public health significance, are generally regarded as air pollutants and must, therefore, be given consideration.

Odor problems may also be associated with wastewater treatment systems, especially where anaerobic ponds are utilized. Dissolved and suspended organic matter contained in processing wastewaters are subject to anaerobic degradation, thereby resulting in the production of malodorous gases. As previously stated, the concentration of organic material is significantly influenced by the degree of hydraulic conveying employed within the processing plant. Thus, solid residuals, water pollution and air pollution are in fact inter-related.

In-plant Processes. Improvements in processing equipment and development of alternative processes have historically been directed toward improvement in the quality of food products, toward increasing the yield or recovery of raw commodities, and toward increasing production rates. However, within the last decade serious efforts have been directed toward reducing environmental problems through process modifications. Cognizance of the inter-relation between in-plant processes and water and air pollution problems has resulted in operational changes which are being implemented in many plants.

In-field Sorting and Washing. To reduce the quantity of culls and trash which must be removed at the processing plant, some products are initially sorted prior to delivery. Such culling operations are generally conducted at a central station in close proximity to the fields. Residuals generated at these stations are most frequently returned to the fields for disposal.

To prevent excessive soil loads and debris from being delivered to the plant, several in-field washing and sorting stations have been established in California for mechanically-harvested tomatoes. Soil-laden wash waters are discharged to the fields or into settling basins; culls and other debris are returned to the harvested fields for incorporation into the soil.

Products and Residuals Handling. During the infancy of the canning industry, products were carried from one operation to another in containers, a mode of conveyance made practical by the small size of processing plants. As the plants were expanded, mechanical conveyors were installed. In relatively recent times, hydraulic systems have become widely employed, not only for conveying raw product, but for handling solid residuals as well. The main advantages of hydraulic systems are the ease and convenience of operation and the aesthetics of easily cleaned and maintained units. However, the primary disadvantage of such systems - namely, the high organic load contained in their wastewater discharges - is becoming widely recognized. For this reason, many processors are returning to the use of dry handling methods.

Among the recently-installed alternative dry handling methods, there appears to be a preference for pneumatic conveyors, primarily negative-air systems. However, product and residuals being handled by such systems are currently limited to peas, lima beans, snap beans, diced carrots, corn and other similarly-sized materials. Negative-air systems are also used to ''vacuum'' spilled materials from floors prior to general plant clean-up with water and detergent solutions. Vacuum systems are also being used at inspection stations to remove defective and otherwise unacceptable product from the process flow.

Vibrating or oscillating table conveyors have been used in some plants to replace belt conveyors and flumes. These conveyors appear to require less maintenance than belts, contribute little or nothing to the organic load and volume of wastewater, and are readily cleaned and sanitized.

The use of containers for accumulating and transporting solid residuals is perhaps the most elementary form of dry handling. To avoid deposition of materials into gutters, as well as to avoid or replace the use of flumes, many processors are returning to the use of containers for handling residuals from sorting and inspection stations. Residuals from these operations are either deposited into pans, buckets, or barrels and transferred to bins or portable hoppers, or deposited directly into the larger containers. The bins or portable hoppers are periodically transported by fork-lift and emptied into waste hauling trucks.

The use of any of these alternative dry handling methods minimizes or eliminates the opportunity for product to come into contact with water. Avoidance of water contact not only reduces the pollutional strength of the wastewater effluent from the plant, but also reduces the amount of free moisture contained in each residuals load. Elimination of unnecessary water will not only result in residuals weight reductions, but may also help to minimize those environmental problems associated with leachate both at the on-site storage facility and at the disposal site.

Processing Operations. Chemical peelers for fruits and root vegetables and water blanchers for vegetables are prime contributors to the organic load contained in liquid wastes. Alternative methods of peeling significantly influence the solid residuals quantity; alternative blanching methods, however, have little effect on solid residuals, but may significantly affect liquid waste characteristics.

Major commodities which are commonly chemically peeled include beets, carrots, sweet potatoes, white potatoes, tomatoes, apples, apricots, peaches and pears. Much of the peel and underlying tissue which are removed by chemical peelers are discharged with the rinse water in a dissolved or finely particulated form. These materials cannot be separated from the liquid waste by conventional means and thus represent a significant portion of the organic load in the wastewater.

Mechanical peelers are commonly used alternative equipment for apples and pears. Mechanically removed peel materials are readily amenable to dry handling methods and are, in fact, frequently so handled, thereby avoiding unnecessary water contact. Thus, the quantity of solid residuals is greater from mechanical peelers than from chemical peelers.

A recently developed alternative peeling process for white potatoes is being widely adopted. This process, developed by the USDA Western Regional Research Laboratory, is called the ''dry'' caustic - infra-red peeler. A caustic solution is initially applied to the surface of the potatoes. After a brief holding period to facilitate caustic penetration, the potatoes are passed under infra-red heaters to further caustic penetration and to soften the potato skin. The softened peel is removed as a thick pumpable slurry by specially designed rollers. The peeled potatoes are then given a light rinse to remove residual caustic and peel. The peel slurry, which under conventional caustic peeling procedures would have been discharged with the rinse water, is collected and pumped to storage hoppers and subsequently mixed with residuals from other operations for utility as animal feed. Significant reductions in the organic load of the liquid waste have resulted from use of this process. Adaptations of this principle for peeling other root vegetables and tree fruits are under study.

Current vegetable blanching techniques are limited to the use of hot water or steam. For optimum product quality, certain vegetables, notably peas, can be blanched only in hot water; blanching methods do not appear to seriously affect product quality for other vegetables. Hot water blanchers leach significant quantities of soluble solids from the product, thereby resulting in high concentrations of BOD and suspended solids. Steam blanchers, on the other hand, generate minor volumes of wastewater and thus contribute minimally to the effluent organic load. Potential alternative methods which may further reduce the organic load contribution of blanchers are under study. These include microwave and hot air blanching, as well as air or low water volume cooling.

Technological Changes. Several persons active in food processing research, engineering and teaching were asked to predict changes in the technology in the next several years and the effects of the changes on wastes and pollution. All types of pollution (solid, liquid, and air) were to be included in the predictions. All of the experts responded. They expected changes in all of the 23 agricultural, harvesting, transporting, processing and waste handling steps that were specifically listed in the query, and they generally expected the changes to improve the waste and pollution situation. A summary of specific comments follows:

New horticultural varieties should permit better utilization and, therefore, less waste. One expert suggested a gain of 1%; another a gain of 50%. Some thought new varieties would not affect wastes. Fertilizer applications and irrigation were expected to be better controlled with less waste and pollution by about half the experts; a few anticipated worse effects from increased applications. Most thought that pesticide pollution would be decreased by improved materials and methods and by better controls. Increased use of other chemicals was expected to increase problems by two respondents, but a majority expected no change or an improvement.

Opinions were divided on the effects of increased mechanical harvest; sorting in the field and once-over harvesting could reduce problems, but more soil and trash could increase them. Similarly, changes in containers and transportation might improve or worsen the problems although overall they were expected to be improved. Most cited bulk handling or hauling in water; some expected more and some less product damage, a factor likely to vary with the product and the hauling method. Most thought that increased sorting and pulping in the field would alleviate waste problems, but one expert said less control could be exercised there.

Nearly all of the many cited examples of changes in in-plant equipment and methods were expected to reduce waste and pollution. There was a small minority pessimistic about product packaging, including a suggestion of increased specialized packaging; but some thought more functional, more re-usable or more destructable packages would come into use. Listed in-plant improvements included: less water usage, more water recirculation, more efficient washing, improved blanching and peeling methods, product transportation methods using no or less water, and more efficient product utilization. The experts expected changes in quality standards and split on whether they would increase or decrease waste and pollution.

Improvements in waste handling were anticipated by nearly all the experts. Cited here were better solid:liquid separation methods, improved or more widely used liquid waste treatment, and the development of more by-products, although one thought the last unlikely. Most expected better solid waste disposal methods but one person was pessimistic about this. Pollution regulations were expected to be stricter.

Laws and Regulations

Regulations administered by the Federal Food and Drug Administration and the U. S. Department of Agriculture, coupled with the food processors' desire to provide wholesome and aesthetically appealing foods, significantly affect the quantity of both solid residuals and liquid waste which are generated during production. All raw commodities are thoroughly inspected and sorted to remove unacceptable product. Defective portions are removed from product which may be otherwise suitable for juice or puree styles. Rejects from these operations, which would otherwise be processed, are discarded as residuals. Processing operations are conducted with heavy emphasis placed on plant and equipment sanitation to assure the production of nutritious and wholesome foods. Thorough equipment and general plant cleanup periods are scheduled during each work shift. Plant sanitation is generally maintained by the use of sanitizing agents or detergent solutions, followed by rinsing with large volumes of potable water.

The inter-relation between solid residuals and water and air pollution necessitates the consideration of all federal, state and local regulations pertaining to environmental problems when handling and disposing of solid residuals. The major federal laws which are directed toward environmental protection include the Refuse Act of 1899(7), the Federal Water Pollution Control Act of 1956 as amended by the Environmental Quality Improvement Act of 1970(8), the Solid Waste Disposal Act of 1965 as amended by the Resource Recovery Act of 1970(9), and the Clean Air Act of 1965 as amended by the Clean Air Amendments of 1970(10). Additionally, all states have laws and regulations dealing with one or more of these subjects; local public health agencies also regulate operations at solid waste disposal sites.

RESEARCH NEEDS

In-Plant Processes

Since many food processing plants are located in urban areas, disposal and/or utilization (especially for animal feed) of food residuals necessitate hauling, frequently for considerable distances. Any measure which results in a reduction of the quantity of residuals which are generated would contribute to cost reductions incurred for handling and to alleviation of some of the environmental problems associated with these residuals. In-field sorting stations for cling peaches, field sheds for cutting and boxing asparagus, and in-field sorting and washing stations for mechanically-harvested tomatoes have each made significant contributions toward this end. The practicality of similar operations for other products could beneficially be investigated.

Studies are currently being conducted to determine the feasibility of preprocessing tomatoes in the field. Considerations are being given to an in-field station where tomatoes for tomato products would be inspected, washed, pulped and finished, and stabilized for bulk aseptic transport. Thus, product received at the plant would be completely utilizable, with only minimal residuals created by rinsing of transport tanks. This concept of in-field preprocessing may be potentially applicable to other products.

The ''dry'' caustic peeling process and alternative blanching methods, as well as pneumatic residuals handling systems, will each significantly reduce the pollutional strength of food processing wastewaters. It is important that all future equipment designs and process modifications be made with consideration given to similarly alleviating environmental problems. Such consideration must especially be included in the site selection, design and construction of new food processing plants.

Solid Residuals Disposal

More than 800,000 tons of the industry's residuals were spread on land, nearly all agricultural land, for disposal. These materials contribute to the structure of the soil and, in a minor way, to its available nutrients. However, in some cases only limited quantities should be returned to the soil to avoid odor and insect problems. In some areas both ground- and surface-water pollution are also potential problems. Very minimal definitive information is currently available on the effects resulting from the incorporation of these materials into soil. Studies to measure physical, chemical and microbiological parameters would be useful in establishing conditions whereby this recycling method can be optimally conducted.

Burning the residuals of many commodities by conventional incineration methods requires significantly more heat input to raise the temperature and especially to evaporate the water contained in the materials than is returned by the combustion. Dewatering (for example, by pressing or filtering) to improve this relationship would merely increase the need for liquid waste treatment since the removed water would contain high concentrations of dissolved solids. Energy input to modify the form of the residuals (for example, by grinding or crushing) may improve combustion efficiency for some materials. However, air pollution problems must be considered when employing conventional incineration systems. Recent advances in fluidized-bed incineration and submerged combustion techniques make these methods promising for the disposal of slurried wastes. Implementation of feasibility studies and economic evaluations for incineration of various food residuals would be desirable.

More than 80,000 tons of seafood residuals were estimated to have been returned to the water, largely to the ocean. These highly nutritious materials were thereby made available to large and to microscopic water-dwelling organisms. Almost 100,000 tons of fruit and vegetable residuals were also disposed of to water and, although they may sometimes create other problems, parts of their nutrients must be used similarly. Smaller quantities of shell were used in shallow ocean water to harbor young oysters. However, legislation which would ban ocean disposal of all solid wastes is being considered. Such food processing residuals cannot, by any established criterion, be classified as a toxic industrial waste. Studies to determine whether properly-conducted ocean disposal of these materials is beneficial to the marine environment should be implemented.

Residuals Utilization

Large proportions of the solid residuals from the surveyed industry are recycled; detailed data are in an earlier section and in the Appendix to this report. However, several factors exist which currently limit the extent to which these materials can be recycled or converted to by-products.

The largest quantity used in by-products (7 million tons), was made up of trimmings, peels, husks, culls, and other portions of many commodities fed to livestock, sometimes as silage or dried material. Some of the factors influencing the use of residuals as animal food are discussed in other sections of this report. The food value of the residuals from many commodities is comparable to that of the whole commodity; for example, spilled products, trimmings for defects, and cullage for defects, for small size, and for under- or over-maturity. Considerations of food standards, contamination, sanitation, and aesthetics keep such materials out of the human food product. Other residuals, such as husks and peels, contain large proportions of cellulose or other materials digestible only after conversion, as by micro-organisms in a ruminant's stomach.

More than 200,000 tons of the industry's food residuals were reused for products other than animal food: charcoal, oil, vinegar, alcohol and several minor materials. Among the factors limiting these uses are: the short production seasons of most commodities and, therefore, the fluctuating supply of residuals (nearly all of which are unstable and cannot be stockpiled); the limited demand for some products (for example, charcoal and abrasives made from fruit pits); the readily available alternative raw materials for some products, which may be more suitable for a given use (for example, alternatives to cull fruit for making alcohol); the distance to a processing or conversion facility; and the small quantities of residuals produced by small food processing plants.

About 200,000 of the 650,000 total tons of non-food residuals accumulated at the industry's plants were used for by-products, mostly remanufactured metals and paper products. Most of the limiting factors mentioned above also apply to non-food by-products recovery.

Where comments regarding research needs were offered on the returned questionnaires, by far the most frequently stated need was for development of by-products from currently unusable residuals. However, these residuals are putrescible, as previously stated, thereby accounting for their current limited utility. Since seasonality appears to be the most significant reason for the limited use of these residuals, development of economic techniques by which such materials can be stabilized and stored for extended periods would without doubt encourage their use for a variety of currently feasible by-products (for example, alcohol and vinegar from fruit residuals and better nutritionally-balanced feeds from vegetable residuals).

Chemical stabilization, microwave and gamma-irradiation sterilization, and microbiological preservation (as by pickling) are potential methods which can be investigated. Another approach worthy of consideration is stabilization by dehydration. Since much of most food residuals is water, dehydration would also reduce the bulkiness of the residuals, thereby reducing the required storage capacity. Improvements in dehydration technology could be advantageously evaluated to determine the economics of adapting such processes for this purpose. Storageability of food residuals will prolong the availability of these materials and may thus encourage the development of new, as well as heretofore uneconomical, by-products.

APPENDICES

APPENDIX A

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APPENDIX B

DETAILED RESIDUALS DATA

Residuals by Region, Product and Month. Following are tabulated data on estimated quantities of solid residuals from each region and commodity each month and in total (Table A1). Also listed are the total raw tonnage and total residual tonnage estimates. The latter include the tons not accounted for (explained in a preceding section). Non-food residuals are given separately.

TABLE A1

SOLID RESIDUALS BY REGION, PRODUCT AND MONTH

NEW ENGLAND	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sept	Oct	Nov	Dec	Total	Total raw tons	Total resid tons
	Tons residuals accounted for (all amounts x 1000)														
asparagus															
bean, lima															
bean, snap							.7	.9	.7				2.3	10	2.3
► beet															
caul, broc, sprouts															
cabbage															
carrot															
corn								2.5	2.5	1.6			6.6	10	7.0
► spin. greens	.1		.2	.1	.1					.1	.1	.1	.8	3	.9
mushroom	.1	.1									.1	.1	.4	1	.4
pea						2.0	1.9						3.9	8	3.6
wh. potato	8.3	8.3	8.3	8.3	8.3	8.3	8.3	8.3	8.3	8.3	8.3	8.3	100.0	700	265.0
► pump./squash								2.1					2.1	4	2.1
tomato															
misc vegetable															
► apple	.4	.8	.4	.3				.3	.9	1.2	1.5	1.2	7.0	23	7.0
apricot															
berry								2.1	.7				2.8	32	3.2
cherry															
► citrus															
misc fruit										.6	.3		.9	5	1.0
olive															
peach															
► pear															
pineapple															
plum/prune															
dry bean		.1											.1	40	.2
pickle						.1	.2						.3	7	.3
► specialties	.4	.4	.4	.4	.5	.5	.5	.5	.4	.4	.4	.4	5.2	30	5.2
clam													.2	2	1.8
oyster															
crab															
► shrimp	3.1	6.3	6.3	3.1	3.1								22.0	40	30.0
salmon															
sardine	.4	.5	.7	.7	.5	.7	.7	.6	.6	.5	.3	.2	6.4	26	6.5
tuna, misc	.3	.3	.3	.3	.3	.4	.5	.6	.7	.5	.5	.3	5.0	35	14.0
TOTAL	13.1	16.8	16.6	13.2	12.8	12.0	12.8	17.8	14.8	13.2	11.5	10.5	165.4	976	350.5
non-food	.3	.3	.6	.6	.3	.6	.6	.6	.6	.5	.4	.3	5.8		

TABLE A1 (con't)
MID ATLANTIC

Tons residuals accounted for (all amounts x 1000)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sept	Oct	Nov	Dec	Total	Total raw tons	Total resid tons
asparagus			1.8	3.5	3.5	1.7							10.5	21	10.6
bean, lima									1.4	1.4			2.9	5	.8
bean, snap						.7	8.3	8.3	8.3	.7			26.3	117	27.0
▶ beet				2.0				1.9	1.9	5.7	5.7	2.0	19.1	91	30.0
caul, broc, sprouts		.6	.7	.7									2.0	10	2.0
cabbage	2.9	2.9	2.9	2.9	1.8	.6		2.9	3.5	4.1	4.1	2.9	31.5	97	33.0
carrot										3.0	3.0		6.0	14	6.0
corn								27.5	27.5	18.4			73.4	112	82.0
▶ spin. greens	.1	.2	.3	.1	.2	.1			.1	.2	.2	.1	1.6	10	1.8
mushroom	1.6	1.6	1.6	1.6	1.6	1.6	.6	.5	.6	1.6	1.6	1.6	16.2	46	19.6
pea						5.4	5.4						10.8	22	10.0
▶ wh. potato	.9	.9	.9	.9	.9	.9	.9	.9	.9	.9	.9	.9	10.7	80	30.0
pump./squash								1.0					1.0	2	1.0
tomato							8.2	18.4	18.4	12.2			57.1	591	78.5
misc vegetable	2.6	2.6	2.6	1.3	1.3	2.6	1.3	2.6	2.6	5.1	3.9	2.6	30.9	60	33.7
▶ apple	7.7	11.4	7.7	3.8				3.8	15.2	19.0	26.7	19.0	114.0	398	112.0
apricot															
berry	.1	.1	.1		.2	.2	.1						.8	8	.8
cherry							1.9	1.4					3.3	26	3.6
▶ citrus															
misc fruit										1.8	.9		2.7	20	3.0
olive															
peach						1.4	.7	.7					2.8	6	2.8
pear								.1	.1	.1	.1		.3	1	.3
▶ pineapple															
plum/prune	.1	.1	.2	.1						.1			.6	2	.5
dry bean	.1	.1	.1	.1		.1		.1		.1	.2	.1	1.0	20	.5
pickle						.2	.2						.4	11	.4
▶ specialties	2.3	2.3	2.3	2.3	2.3	1.7	1.2	1.2	1.2	1.7	1.7	2.3	22.5	180	22.5
clam	.7	.7	.7	.6	.6	.6	.6	.6	.6	.7	.7	.7	7.8	80	69.0
oyster															
▶ crab															
shrimp															
salmon															
sardine															
tuna, misc	.3	.3	.2	.2	.2	.3	.4	.4	.5	.4	.4	.3	4.0	30	13.0
TOTAL	19.4	23.8	22.1	20.1	12.6	18.1	29.8	72.3	82.8	77.2	50.1	32.5	460.8	2,060	594.4
non-food	10.0	10.0	10.0	7.6	8.8	6.3	8.8	12.6	11.4	13.9	10.0	10.0	120.0		

TABLE A·1 (con't)

SOUTH ATLANTIC

Tons residuals accounted for (all amounts x 1000)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sept	Oct	Nov	Dec	Total	Total raw tons	Total resid tons
asparagus				.6	.8	.6							2.0	8	2.0
bean, lima								.8	.8				1.6	16	1.6
bean, snap				1.6	1.6	2.1	1.6	.5	.5				7.8	61	9.4
beet								.1	.1	.1	.1		.4	2	.5
caul, broc, sprouts															
cabbage	.4	.4	.4	.4	.2	.1		.4	.5	.5	.5	.4	4.1	13	4.5
carrot										1.5	1.5		3.0	7	3.0
corn							32.2	32.3					64.5	91	65.3
spin. greens	.7	.7	1.1	.7	1.0	.4			.3	1.1	1.1	.7	7.6	42	8.7
mushroom	.2	.2	.2	.2	.2	.2	.2	.2	.2	.2	.2	.2	2.4	6	2.4
pea					2.0	2.0							4.0	40	4.0
wh. potato	2.1		2.1	2.1	4.2	4.2	4.2	2.1	2.1				23.0	60	27.0
pump./squash								10.4					10.4	20	10.4
tomato	6.6	6.6	6.5	6.5	6.5	6.5			6.5			6.5	52.2	228	64.0
misc vegetable	2.1	2.1	2.1	2.1	2.1		8.4	14.7	12.6	10.5	10.5	4.2	71.5	340	75.0
apple	10.0								10.0	20.0	20.1	20.0	80.1	224	80.1
apricot															
berry													0.0	1	0.0
cherry															
citrus	283.0	283.0	283.0	283.0	283.0	283.0	170.0	57.0	57.0	114.0	170.0	283.0	2,550.0	6,534	2,850.0
misc fruit										.6	.2		.7	5	.8
olive															
peach						19.0	9.5	9.5					38.0	81	35.7
pear															
pineapple															
plum/prune								.1					.1	1	.1
dry bean	.1	.1	.1								.1	.1	.5	10	.6
pickle	.3	.3	.3	.3	.3	.3	.3	.3		.1	.1	.1	2.7	132	2.6
specialties	3.9	3.9	3.9	3.8	3.8	3.5	3.4	3.5	3.5	3.8	3.9	3.9	44.8	350	44.8
clam	.4	.4	.4	.4	.3	.3	.3	.4	.4	.4	.4	.4	4.5	5	4.5
oyster	1.3	1.3	1.3	1.3						1.3	1.3	1.3	9.1	10	9.0
crab	.2	.2	.2	.2	.1	.1	.1	.1	.1			.1	1.4	2	1.5
shrimp															
salmon															
sardine															
tuna, misc	.3	.3	.2	.2	.2	.3	.4	.4	.5	.4	.4	.3	4.0	30	13.0
TOTAL	311.6	299.5	301.8	303.4	306.3	322.6	230.6	132.8	95.1	154.5	210.4	321.2	2,990.8	8,319	3,320.5
non-food	5.6	6.2	5.6	6.2	6.2	6.2	5.1	5.6	5.6	5.1	5.1	6.7	69.2		

TABLE A1 (con't)

NORTH CENTRAL

Tons residuals accounted for (all amounts x 1000)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sept	Oct	Nov	Dec	Total	Total raw tons	Total resid tons
asparagus					.2	1.1	1.1	.2					2.6	17	4.1
bean, lima								.7	.7	.6	.1	.1	2.2	17	2.2
bean, snap							8.4	12.2	10.3	2.8			33.6	131	32.5
beet							3.4	6.7	10.1	11.8	6.7		38.8	100	48.5
caul, broc, sprouts			.1	.1									.2	1	.2
cabbage								4.2	7.1	8.5	5.7	1.4	26.9	86	27.0
carrot	.9	.9	.9	.9	1.8	1.9	6.5	7.4	13.0	10.2	2.8		47.2	110	53.2
corn							23.0	424.0	376.0	148.0			971.0	1,498	987.0
spin. greens						.2			.1				.3	6	2.1
mushroom	1.0	.9	.9	.9	.9	.9	.9	.9	.9	.9	1.0	1.0	11.1	8	5.5
pea						10.4	13.7	6.3					30.4	289	33.4
wh. potato	19.4	12.9	12.9	6.4	6.4	6.4	12.9	19.4	12.9	25.8	38.7	25.8	200.0	360	117.0
pump./squash									3.9	9.8	3.9		17.6	100	91.5
tomato								26.0	28.3	20.7			75.0	1,108	101.0
misc vegetable	1.2	1.2	1.2	1.2	3.6	2.4	1.2	1.2	1.2	4.8	6.0	1.2	26.5	80	27.3
apple	3.2	2.4	1.6	1.6	.8			1.6	3.3	8.1	8.2	7.3	38.2	170	57.0
apricot															
berry						.2	.3	.5	.2				1.2	28	1.6
cherry							8.9	8.9					17.8	123	19.1
citrus															
misc fruit							.4	.4	.7	.8	.4	.3	3.0	20	3.3
olive															
peach								.6	.6				1.2	3	1.2
pear								.6	1.3	.6	.6		3.1	9	3.1
pineapple															
plum/prune	.2	.2	.2	.2		.1			.8	.9	.2	.2	3.0	10	3.2
dry bean	.4	.4	.4	.3	.4	.1	.1		.1	.4	.4	.4	3.3	90	3.3
pickle						4.4	4.5	4.5	4.5	4.4			22.3	216	11.4
specialties	12.0	12.0	12.0	12.0	11.0	11.0	11.0	11.0	12.0	12.0	12.0	12.0	140.0	1,300	140.0
clam															
oyster															
crab															
shrimp															
salmon															
sardine															
tuna, misc			.1	.1	.1	.1	.1	.2	.2	.1	.1		1.0	10	4.0
TOTAL	33.2	30.9	30.3	23.7	25.2	39.2	96.4	537.5	488.2	271.2	86.8	49.7	1,717.4	5,890	1,779.7
non-food	7.3	6.8	6.8	6.3	6.3	13.6	18.8	22.0	22.0	17.2	10.4	8.9	147.0		

TABLE A1 (con't)
SOUTH CENTRAL

Tons residuals accounted for (all amounts x 1000)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sept	Oct	Nov	Dec	Total	Total raw tons	Total resid tons
asparagus					.1	.1							.2	1	.2
bean, lima								.3	.5	.2			1.1	7	1.1
bean, snap				.9	.9	.9	.9	.9	1.8	2.7	.9		9.9	68	10.8
beet	2.2				1.1	1.1						1.1	5.5	27	5.6
caul, broc, sprouts		.2	.1	.1									.4	2	.4
cabbage	.6	.5	.5								.5	.6	2.7	9	2.7
carrot	.2	.2	.4	.7	.2								1.7	10	4.2
corn						8.5							8.5	10	8.5
spin. greens	1.5	1.4	2.2	.7	.7				.7	.7	1.4	1.5	10.8	85	11.5
mushroom															
pea				.5	.5	.5	.9	.9	.9	.5	.5	.4	5.6	10	5.6
wh. potato							1.0	1.1					2.1	40	15.0
pump./squash									3.1	7.8	3.1		14.0	37	14.0
tomato								2.0	1.7	1.3			5.0	71	6.0
misc vegetable	3.7	3.7	3.8	3.8	3.8	5.6	7.5	7.5	7.5	7.5	5.6	3.7	63.9	180	64.1
apple															
apricot															
berry															
cherry															
citrus	8.2	8.2	8.2	8.2	8.2	8.2	4.9	1.6	1.6	3.3	4.9	8.2	74.0	189	82.0
misc fruit	.2	.3	.3	.5	.6	.6	.6	.5	.3	.3	.3	.3	4.8	10	5.2
olive															
peach															
pear															
pineapple															
plum/prune															
dry bean	.2	.1	.1	.1	.1	.1	.1	.1	.1	.1	.2	.2	1.5	30	1.4
pickle						1.6	1.6	1.6	1.6	1.6			8.0	79	4.0
specialties	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.6	2.6	2.6	2.6	2.5	30.4	230	30.4
clam															
oyster	.7	.7	.6	.6						.6	.6	.7	4.5	5	4.5
crab															
shrimp	1.8	.9	.9	2.7	4.5	4.6	4.6	4.6	4.6	4.6	4.6	4.6	43.0	80	54.0
salmon															
sardine															
tuna, misc	.3	.3	.3	.3	.3	.4	.5	.6	.7	.5	.5	.3	5.0	35	14.0
TOTAL	22.1	19.0	19.9	21.6	23.5	34.7	25.1	24.3	27.7	34.3	25.7	24.1	302.0	1,215	345.2
non-food	6.2	6.2	6.2	6.2	6.2	6.2	6.2	6.2	6.2	6.2	6.1	6.1	74.0		

TABLE A1 (con't)

MOUNTAIN

Tons residuals accounted for (all amounts x 1000)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sept	Oct	Nov	Dec	Total	Total raw tons	Total resid tons
asparagus															
bean, lima								.1	.1	.1			.3	2	.2
bean, snap							.5	.9	.5				1.9	16	1.7
► beet							.8	.8					1.6	4	1.6
caul, broc, sprouts															
cabbage								.1	.1	.1			.3	2	.3
carrot															
corn								7.5	7.4				14.9	30	18.7
► spin. greens															
mushroom															
pea						.4	.6	.3					1.3	10	2.6
► wh. potato									1.0	1.0	1.0	1.0	4.0	10	4.0
pump./squash									.2	.2	.1		.5	5	3.3
tomato								8.5	10.2	10.2			28.9	65	30.6
misc vegetable						1.0	1.0	1.0	1.0				4.0	20	4.0
► apple									.9	.9	1.0	.9	3.7	20	6.0
apricot															
berry															
cherry							.9	.9					1.8	9	1.8
► citrus															
misc fruit															
olive															
peach									2.7				2.7	14	3.7
pear								.1	.1	.1	.1		.4	1	.4
► pineapple															
plum/prune															
dry bean			.1	.1									.2	10	.2
pickle						.7	.7	.7	.7				2.8	27	2.8
► specialties															
clam															
oyster															
crab															
► shrimp															
salmon															
sardine tuna, misc															
TOTAL			.1	.1		2.1	4.5	20.9	24.9	12.6	2.2	1.9	69.3	245	81.9
non-food						.1	.3	.5	.4	.3	.1	.1	1.8		

TABLE A1 (con't)

NORTHWEST

Tons residuals accounted for (all amounts x 1000)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sept	Oct	Nov	Dec	Total	Total raw tons	Total resid tons
asparagus				1.5	1.6	1.6	.5						5.2	24	5.5
bean, lima						.1	.1	.2	.5	.2			1.2	10	1.2
bean, snap						.8	14.2	14.2	11.1	.8			41.2	174	39.4
beet							4.6	6.1	6.1	4.6	1.5		23.0	44	23.0
caul, broc, sprouts								7.3	7.3	7.4	7.3		29.4	42	28.1
cabbage									2.9	3.0	2.9	1.5	10.3	25	7.2
carrot	1.4								5.7	15.5	15.5	7.1	45.2	83	46.3
corn							15.0	125.0	179.0	117.0	48.0		484.0	729	496.0
spin. greens			.5	.6	.1	.1		.1					1.4	11	1.4
mushroom	.1	.1	.1	.1					.1	.1	.1	.1	.8	2	.9
pea					.8	4.5	6.0	3.6	.4				15.3	183	15.3
wh. potato	68.0	68.0	68.0	68.0	68.0	41.0	41.0	68.0	81.0	94.0	81.0	81.0	826.0	2,300	876.0
pump./squash							1.4	1.4	1.4	2.8	2.7		9.7	20	9.7
tomato															
misc vegetable	.6	.6	.6		.6	.6	1.2	.6	1.2	1.2	.6	.6	8.5	70	8.1
apple	1.6	1.6	1.3	.6	.6				.6	1.0	1.6	1.9	10.9	50	13.2
apricot							.2						.2	1	.2
berry						2.5	2.4	1.4	.8	.1			7.2	97	7.6
cherry						.7	1.3	.2					2.2	17	2.1
citrus															
misc fruit								.6	.6	1.2			2.4	10	2.4
olive															
peach									2.5				2.5	13	3.4
pear								10.6	13.3	10.6	5.3		39.9	115	43.4
pineapple															
plum/prune								.1	.6	.1			.8	10	1.4
dry bean	.1		.1	.1									.3	10	.2
pickle						.4	.5	.5	.4				1.8	19	1.8
specialties	.6	.6	.6	.7	.7	.7	.7	.7	.7	.7	.7	.6	8.0	60	8.0
clam															
oyster	.6	.6	.6	.6	.5					.5	.6	.6	4.6	5	4.6
crab	.7	.7	.7	.7	.7	.4	.3	.3	.3			.7	5.5	8	6.3
shrimp															
salmon	.1	.1	.1	.1	.2	.2	.2	.3	.2	.2	.1		1.8	8	1.8
sardine															
tuna, misc	1.6	1.6	1.6	1.7	1.7	1.7	2.4	3.2	3.2	2.4	2.3	1.6	25.0	170	72.0
TOTAL	75.4	73.9	74.2	74.7	75.5	55.3	92.0	244.4	318.7	263.4	170,2	95.7	1,613.4	4,310	1,726.5
non-food	5.0	5.0	3.9	5.0	5.6	10.0	10.6	11.2	14.0	12.8	9.5	5.5	98.0		

TABLE A1 (con't)

ALASKA

Tons residuals accounted for (all amounts x 1000)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sept	Oct	Nov	Dec	Total	Total raw tons	Total resid tons
asparagus															
bean, lima															
bean, snap															
▶ beet															
caul, broc, sprouts															
cabbage															
carrot															
▶ corn															
spin. greens															
mushroom															
pea															
▶ wh. potato															
pump./squash															
tomato															
misc vegetable															
▶ apple															
apricot															
berry															
cherry															
▶ citrus															
misc fruit															
olive															
peach															
▶ pear															
pineapple															
plum/prune															
dry bean															
pickle															
▶ specialties															
clam						.1	.2	.1					.4	3	2.5
oyster															
crab	1.5	.9	.9	.6	.3	1.5	.9	1.2	1.8	2.0	2.1	1.5	15.2	20	15.2
▶ shrimp	.2	.1			.1	.2						.3	.9	2	1.7
salmon						7.7	11.6	9.7	7.7	2.0			38.7	116	41.7
sardine															
tuna, misc					.6	.7	.7						2.0	20	2.0
TOTAL	1.7	1.0	.9	.6	1.0	10.2	13.4	11.0	9.5	4.0	2.1	1.8	57.2	161	63.1
non-food						.3	.4	.2	.1	.1	.1		1.1		

TABLE A1 (con't)

SOUTHWEST

Tons residuals accounted for (all amounts x 1000)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sept	Oct	Nov	Dec	Total	Total raw tons	Total resid tons
asparagus			2.0	8.0	8.0	4.0							22.0	45	22.8
bean, lima							.3	3.3	3.6	2.6	.3		10.1	58	9.2
bean, snap						2.2	2.2	2.7	1.8	1.8			10.8	50	10.8
beet							.2	.3	.3	.2	.1		1.1	2	1.0
caul, broc, sprouts	6.9	4.8	6.4	6.4	6.4	6.9	4.8	5.3	5.3	8.6	9.1	9.6	80.8	200	82.4
cabbage															
carrot	3.0	1.5	2.9	3.0	1.5	3.0	2.9	3.0	4.4	3.0	3.0	4.4	35.5	60	35.5
corn															
spin. greens			3.7	4.8	1.0	.2		.2	.3	.3			10.4	82	10.8
mushroom	.2	.2	.2	.1	.1	.1			.1	.1	.2	.2	1.5	4	1.8
pea				.9	1.6								2.5	20	3.6
wh. potato				.7	2.0	1.3	.7						4.6	20	7.5
pump./squash									1.2	1.2	.6		3.0	36	23.5
tomato						3.3	62.2	82.0	82.0	69.0	6.5		305.0	4,903	392.0
misc vegetable	1.1	2.2	2.2	2.2	5.4	6.6	9.8	10.9	9.8	8.7	5.5	3.3	67.7	470	61.0
apple	5.2	5.2	4.1	2.1	2.1				2.1	3.1	5.2	6.3	35.4	161	43.8
apricot	.5	.5	.5	.5		6.1	7.1						15.3	114	20.4
berry				.2	.3	.4	.4	.1	.1	.1			1.6	38	2.2
cherry					.2	.5							.7	12	.7
citrus	45.0	45.0	45.0	44.0	44.0	44.0	44.0	44.0	44.0	44.0	45.0	45.0	533.0	1,074	538.0
misc fruit						2.0	3.5	6.0	7.0	3.0			21.4	80	23.4
olive	.7	.7	.4		.3	.4	.3		2.2	3.2	2.9	.3	11.4	85	11.5
peach						3.0	74.0	88.0	77.0	3.0			245.0	981	226.0
pear							14.0	22.0	24.0	14.0			74.0	280	85.0
pineapple	25.0	25.0	30.0	50.0	55.0	55.0	55.0	55.0	30.0	25.0			405.0	900	405.0
plum/prune	.3	.4	.4			.7	.4						2.2	5	2.4
dry bean	.1	.1	.1	.1								.1	.5	20	.4
pickle						.7	.8	.8	.8				3.1	64	3.1
specialties	4.0	4.1	4.1	4.1	4.1	4.1	4.1	4.1	4.1	4.1	4.1	4.0	49.0	350	49.0
clam															
oyster															
crab															
shrimp															
salmon															
sardine tuna, misc	4.4	4.4	4.4	4.4	4.4	4.4	4.4	4.4	4.4	4.4	4.4	4.4	53.0	195	58.0
TOTAL	96.4	94.1	102.4	131.4	136.3	148.8	291.0	332.0	304.4	199.3	86.9	77.6	2,000.6	10,309	2,130.8
non-food	4.9	3.3	6.9	10.9	9.8	11.8	18.0	17.5	18.2	17.0	7.8	5.1	132.7		

Residuals by Region, Product and Disposal Method. Table A2 is on estimated quantities of solid residuals from each region and commodity and by each method of disposal or use. The last column on each page gives the estimated tons not accounted for. Non-food residuals are listed separately with different headings for by-product uses; the other column headings (fill, spread, etc.) also apply to non-food residuals.

TABLE A2

SOLID RESIDUALS BY REGION, PRODUCT AND DISPOSAL METHOD

Tons residuals accounted for (all amounts x 1000)

NEW ENGLAND	fill	spread	burn	water	pond	sewer	irrig	feed	char	alc	oil	vin	other	total	tons not acc't for
asparagus															
bean, lima															
bean, snap	1.1	.3						.9						2.3	0
► beet															
caul, broc, sprouts															
cabbage															
carrot															
corn	.4							6.1						6.6	.7
► spin greens	.1	.1						.6						.8	.1
mushroom	.1	.1												.4	.1
pea		.2						3.7						3.9	(-.3)
wh. potato								100.0						100.0	165.0
► pump./squash		.3				1.8								2.1	0
tomato															
misc. vegetable															
apple	.1	3.1										.5	3.1	7.0	0
► apricot															
berry	.2		.7	1.8	.1									2.8	.4
cherry															
► citrus															
misc. fruit		.9												.9	.1
olive															
peach															
pear															
► pineapple															
plum/prune															
dry bean	.1													.1	.1
pickle	.3													.3	0
► specialties	.4												4.8	5.2	-
clam	.2													.2	1.6
oyster															
crab															
► shrimp				21.4									.5	22.0	8.0
salmon															
sardine															
tuna													6.4	6.4	.1
misc.								4.0					1.0	5.0	9.0
TOTAL	3.0	5.0	.7	23.2	.1	1.8		115.3				.5	15.8	165.4	184.9
									metal		paper		other		
non-food	3.2		2.5											5.8	

TABLE A2 (con't)
MID ATLANTIC

Tons residuals accounted for (all amounts x 1000)

	fill	spread	burn	water	pond	sewer	irrig	feed	char	alc	oil	vin	other	total	tons not acc't for
asparagus	1.8	8.7												10.5	.1
bean, lima		2.9												2.9	(-2.0)
bean, snap	13.0	5.7						7.6						26.3	.6
beet	6.1	12.6						.4						19.1	11.0
caul, broc, sprouts								2.0						2.0	0
cabbage	5.0	21.6			4.9									31.5	1.7
carrot		6.0												6.0	0
corn		4.5						69.1						73.4	8.3
spin greens	.1	.1						1.3						1.6	.2
mushroom	3.5	12.8												16.2	3.3
pea		.6						10.2						10.8	(-.8)
wh. potato	10.7													10.7	19.3
pump./squash		.2				.9								1.0	0
tomato	38.7	17.1			.4			1.0						57.1	21.4
misc. vegetable	16.4	14.5												30.9	2.8
apple	2.4	50.0			.3							10.5	51.0	114.0	(-2.0)
apricot															
berry		.8												.8	0
cherry	1.4	1.9												3.3	.4
citrus															
misc. fruit		2.7												2.7	.3
olive															
peach	2.1	.2						.6						2.8	(-.2)
pear	.3													.3	0
pineapple															
plum/ prune	.6													.6	(-.1)
dry bean	.6	.3	.1											1.0	(-.5)
pickle	.4													.4	0
specialties	5.3					.2		14.0					2.8	22.5	-
clam	7.8													7.8	61.2
oyster															
crab															
shrimp															
salmon															
sardine															
tuna															
misc.								3.0					1.0	4.0	9.0
TOTAL	116.2	163.6	.1		5.6	1.1		109.2				10.5	54.8	460.8	134.0
									metal		paper		other		
non-food	16.0		1.0						68.0		34.0			120.0	

TABLE A2 (con't)
SOUTH ATLANTIC

Tons residuals accounted for (all amounts x 1000)

	fill	spread	burn	water	pond	sewer	irrig	feed	char	alc	oil	vin	other	total	tons not acc't for
asparagus		2.0												2.0	0
bean, lima		1.6												1.6	0
bean, snap	.1	.3				1.5		5.9						7.8	1.5
► beet	.1	.2												.4	.2
caul, broc, sprouts															
cabbage	.7	2.9			.7									4.1	.2
carrot		3.0												3.0	0
corn		13.5						51.0						64.5	.8
► spin greens	1.1	.2			.2			6.3						7.6	1.1
mushroom		2.4												2.4	0
pea		4.0												4.0	0
wh. potato	3.3				.4	3.9		15.4						23.0	4.0
► pump./squash		1.6				8.8								10.4	0
tomato		33.9						18.4						52.2	11.8
misc. vegetable	8.9	7.0			1.0	49.0		5.6						71.5	3.5
apple	4.3							75.8						80.1	0
► apricot															
berry														0	0
cherry															
citrus	4.0	76.0					.2	2467.0			3.0			2,550.0	300.0
► misc. fruit		.7												.7	.1
olive															
peach	27.5	2.9			.2			7.2						38.0	(-2.1)
pear															
► pineapple															
plum/ prune		.1												.1	0
dry bean	.2							.3						.5	.1
pickle	2.7													2.7	(-.1)
► specialties	11.8					.3	.1	30.4					2.3	44.8	-
clam		4.5												4.5	0
oyster				1.3									7.7	9.1	(-.1)
crab	1.0	.2		.2										1.4	.1
► shrimp															
salmon															
sardine															
tuna															
misc.								3.0					1.0	4.0	9.0
TOTAL	65.7	157.0		1.5	2.5	63.5	.3	2686.3			3.0		11.0	2,990.0	330.1
									metal		paper		other		
non-food	25.5		38.2						5.5					69.2	

TABLE A2 (con't)

NORTH CENTRAL

Tons residuals accounted for (all amounts x 1000)

	fill	spread	burn	water	pond	sewer	irrig	feed	char	alc	oil	vin	other	total	tons not acc't for
asparagus	1.2	1.2						.2						2.6	1.5
bean, lima		2.1						.2						2.2	0
bean, snap	6.6	20.5						6.7						33.6	(-1.2)
beet	3.3	33.6						1.8						38.8	9.8
caul, broc, sprouts								.2						.2	0
cabbage	7.2	19.7												26.9	.1
carrot	.4	21.5	.1					25.3						47.2	6.0
corn	2.4	63.9	.5			.1	1.0	903.0						971.0	16.0
spin greens								.3						.3	1.8
mushroom		10.9		.2										11.1	(-5.6)
pea	1.9	16.7	.1					11.6						30.4	3.0
wh. potato	18.4	4.2						177.4						200.0	(-83.0)
pump./squash	.4	6.5			.2			9.7					.8	17.6	73.9
tomato	27.2	19.6			4.9		.9	22.5						75.0	25.5
misc. vegetable	.1	13.4						13.0						26.5	.8
apple	18.0	1.1					.1	.5				18.5		38.2	18.8
apricot															
berry	.7	.4						.1						1.2	.4
cherry	9.9	3.0	.2				.9	3.7						17.8	1.4
citrus															
misc. fruit	1.5	1.6												3.0	.3
olive															
peach	.6	.4					.2							1.2	0
pear	3.1													3.1	0
pineapple															
plum/prune	1.2	1.8												3.0	.3
dry bean	1.4	1.9												3.3	0
pickle	22.3													22.3	(-10.9)
specialties	13.0	3.0	8.3		6.7	12.7	.1	96.6					.2	140.0	-
clam															
oyster															
crab															
shrimp															
salmon															
sardine															
tuna															
misc.								1.0						1.0	3.0
TOTAL	140.8	247.0	9.2	.2	11.8	12.8	3.2	1273.8				18.5	1.0	1,717.4	61.9
									metal		paper		other		
non-food	81.0		17.0						27.0		8.0		13.0	147.0	

TABLE A2 (con't)
SOUTH CENTRAL

Tons residuals accounted for (all amounts x 1000)

	fill	spread	burn	water	pond	sewer	irrig	feed	char	alc	oil	vin	other	total	tons not acc't for
asparagus	.1	.1												.2	0
bean, lima		.9						.1						1.1	0
bean, snap		3.6						6.2						9.9	1.0
► beet								5.5						5.5	.1
caul, broc, sprouts								.4						.4	0
cabbage								2.7						2.7	0
carrot								1.7						1.7	2.5
► corn								8.5						8.5	0
spin greens		1.4						9.4						10.8	.7
mushroom															
pea								5.6						5.6	0
► wh. potato								2.1						2.1	12.9
pump./squash	.3	5.2			.2			7.7					.6	14.0	0
tomato	1.7	1.3			.3		..1	1.4						5.0	1.5
misc. vegetable	8.4	7.7				.4		47.4						63.9	.2
► apple															
apricot															
berry															
cherry															
► citrus		3.0						71.0						74.0	8.0
misc. fruit	1.8							3.0						4.8	.4
olive															
peach															
► pear															
pineapple															
plum/prune															
dry bean								1.5						1.5	(-.1)
► pickle	8.0													8.0	(-4.0)
specialties	3.1					4.5		20.0					1.4	30.4	-
clam															
oyster				.7									3.9	4.5	0
► crab															
shrimp		4.4	2.9	6.8		12.2		16.5						43.0	11.0
salmon															
sardine															
tuna															
misc.								4.0					1.0	5.0	9.0
TOTAL	23.4	27.6	2.9	7.5	.5	17.1	.1	214.7					6.9	302.0	43.2
									metal		paper		other		
non-food	42.0		8.0						21.0		4.0			74.0	

TABLE A2 (con't)

MOUNTAIN

Tons residuals accounted for (all amounts x 1000)

	fill	spread	burn	water	pond	sewer	irrig	feed	char	alc	oil	vin	other	total	tons not acc't for
asparagus															
bean, lima								.3						.3	0
bean, snap	.3	.2						1.4						1.9	(-.2)
beet	.8					.8								1.6	0
caul, broc, sprouts															
cabbage		.3												.3	0
carrot															
corn		2.2						12.7						14.9	3.8
spin greens															
mushroom															
pea								1.3						1.3	1.3
wh. potato	.5	.5						3.0						4.0	0
pump./squash	.4							.1						.5	2.8
tomato	7.5				1.8	.3		19.2						28.9	1.7
misc. vegetable								4.0						4.0	0
apple	.2							3.5						3.7	2.3
apricot															
berry															
cherry	1.8													1.8	0
citrus															
misc. fruit															
olive															
peach	2.3							.4						2.7	1.0
pear	.2	.1						.1						.4	0
pineapple															
plum/prune															
dry bean	.2													.2	0
pickle	2.3					.5								2.8	0
specialties															
clam															
oyster															
crab															
shrimp															
salmon															
sardine															
tuna misc.															
TOTAL	16.5	3.3			1.8	1.6		46.0						69.3	12.7
									metal		paper		other		
non-food	1.6		.2											1.8	

TABLE A2 (con't)

NORTHWEST

Tons residuals accounted for (all amounts x 1000)

	fill	spread	burn	water	pond	sewer	irrig	feed	char	alc	oil	vin	other	total	tons not acc't for
asparagus	2.0							3.2						5.2	.3
bean, lima								1.2						1.2	(-.1)
bean, snap	11.2	1.4			.1	1.3		27.2						41.2	(-1.7)
▶ beet	7.4					5.3		10.3						23.0	(-.1)
caul, broc, sprouts		5.9						23.5						29.4	(-1.2)
cabbage	6.5							3.8						10.3	(-3.1)
carrot	5.4					2.4		37.3					.2	45.2	1.0
▶ corn	.9	1.1				1.4	.1	481.0						484.0	12.0
spin greens	.5	.1						.8						1.4	0
mushroom	.2	.6												.8	.1
pea		.3						14.8					.2	15.3	0
▶ wh. potato	22.5	23.5		42.0	2.0			736.0						826.0	50.0
pump./squash	4.0							5.5					.2	9.7	0
tomato															
misc. vegetable	3.0							5.5						8.5	(-.4)
▶ apple	2.5							7.6				.9		10.9	2.5
apricot	.2													.2	0
berry	2.1	4.0	.3			.1		.8						7.2	.4
cherry	1.2	.4						.4		.2				2.2	(-.1)
▶ citrus															
misc. fruit		2.4												2.4	0
olive															
peach	2.2							.3						2.5	.9
▶ pear	24.0	7.9				.2		7.8						39.9	3.5
pineapple															
plum/prune	.4	.1						.3						.8	.5
dry bean	.2													.3	(-.1)
▶ pickle	1.4					.4								1.8	0
specialties	.4							7.0					.7	8.0	-
clam															
oyster													4.6	4.6	0
▶ crab	4.2	.6		.7										5.5	.8
shrimp															
salmon				.6				.8			.3		.1	1.8	.1
sardine															
tuna															
misc.								19.0					6.0	25.0	47.0
TOTAL	102.4	48.3	.3	43.3	2.1	11.1	.1	1393.1		.2	.3	.9	12.0	1,613.4	110.3
									metal		paper		other		
non-food	53.0		12.0		32.0				.2		.3			98.0	

TABLE A2 (con't)
ALASKA

Tons residuals accounted for (all amounts x 1000)

	fill	spread	burn	water	pond	sewer	irrig	feed	char	alc	oil	vin	other	total	tons not acc't for
asparagus															
bean, lima															
bean, snap															
beet															
caul, broc, sprouts															
cabbage															
carrot															
corn															
spin greens															
mushroom															
pea															
wh. potato															
pump./squash															
tomato															
misc. vegetable															
apple															
apricot															
berry															
cherry															
citrus															
misc. fruit															
olive															
peach															
pear															
pineapple															
plum/prune															
dry bean															
pickle															
specialties															
clam				.4										.4	2.1
oyster				15.2										15.2	0
crab				.9										.9	.7
shrimp				34.0				3.0			1.4		.3	38.7	3.0
salmon															
sardine tuna misc.													2.0	2.0	0
TOTAL				50.5				3.0			1.4		2.3	57.2	5.8
									metal		paper		other		
non-food	.2	.2	.5	.2										1.1	-

TABLE A2 (con't)
SOUTHWEST

	Tons residuals accounted for (all amounts x 1000)														
	fill	spread	burn	water	pond	sewer	irrig	feed	char	alc	oil	vin	other	total	tons not acc't for
asparagus	3.0	3.8						15.2						22.0	.8
bean, lima	1.2	.8						8.1						10.1	(-.9)
bean, snap	2.6							8.2						10.8	0
► beet	.4					.2		.5						1.1	0
caul, broc, sprouts	12.1	3.3				.6		65.0						80.8	1.7
cabbage															
carrot								35.5						35.5	0
► corn															
spin greens	3.5	.9				.3		5.8						10.4	.4
mushroom	.4	1.1												1.5	.3
pea	.7							1.8						2.5	1.7
► wh. potato	1.7							2.9						4.6	2.9
pump./squash	2.4							.6						3.0	20.5
tomato	171.0	59.0		20.9		.1		54.0						305.0	87.0
misc. vegetable	1.5	28.5	3.7			2.1		31.9						67.7	(-6.7)
► apple	7.9			.1				24.4				2.8		35.4	8.2
apricot	4.1	1.8		.5				7.0	.6		.4		.9	15.3	5.1
berry	1.2					.1		.3						1.6	.6
cherry	.6							.1						.7	.1
► citrus							1.0	532.0						533.0	5.0
misc. fruit	9.4	4.5				.2		4.8		2.4				21.4	2.1
olive	.4	.9	.5		.1						9.5			11.4	.1
peach	94.0	53.0		13.0		1.0		41.0	29.0	15.0				245.0	(-19.0)
► pear	12.6	23.5		9.5				28.4						74.0	10.7
pineapple	30.0			5.0		5.0		365.0						405.0	0
plum/prune	1.3	.1		.9										2.2	.2
dry bean	.5					.1								.5	(-.1)
► pickle		3.1												3.1	0
specialties	2.6		.1					40.6	.3				4.0	49.0	-
clam															
oyster															
► crab															
shrimp															
salmon															
sardine															
tuna															
misc.				.2				35.0			18.0			53.0	5.0
TOTAL	365.1	184.3	4.3	50.1	.1	9.7	1.0	1308.1	29.9	17.4	27.9	2.8	4.9	2,000.6	125.1
									metal		paper		other		
non-food	77.5	17.1	17.1						12.0		5.0		3.0	132.7	

Detailed Data by Product. Table A3, with a separate page for each commodity, lists estimates of the following: the total raw tons processed per year in each region; the number of plants and percentage of U.S. total raw tons in the survey; the average percent yield (usable product as a percentage of delivered raw tons); the total solid residuals (including tons not accounted for); the average plant size in the survey sample in raw tons per year; and for each region the residual tons each month and the residual tons to each type of disposal. The number of plants and the average raw tons per plant are not given for products represented by only a few plants in the survey.

TABLE A3

DETAILED DATA BY PRODUCT

ASPARAGUS

REGION	Total Raw tons, 1000
New England	
Mid Atlantic	21
South Atlantic	8
North Central	17
South Central	1
Mountain	
Northwest	24
Alaska	
Southwest	45
TOTAL	116

Number of plants in survey sample	20	
% of raw tons in survey sample	56	%
Estimated percent yield	61	%
Estimated total residuals	45,000	tons
Average raw tons/plant in survey sample	3,000	tons

RESIDUAL TONS BY MONTH AND REGION, 1000 tons

REGION	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
New England													
Mid Atlantic			2	4	3	2							10
South Atlantic				1	1	1							2
North Central					x	1	1	x					3
South Central					x	x							x
Mountain													
Northwest				1	2	2	x						5
Alaska													
Southwest			2	8	8	4							22
TOTAL			4	14	14	9	2	x					42

RESIDUAL TONS BY DISPOSAL METHOD AND REGION, 1000 tons

	handled as solid waste				handled in liquid waste					by-products			Not. acct'd. for
REGION	fill	spread	burn	total	water	pond	sewer	irrig.	total	feed	other	total	1000 T
New England													
Mid Atlantic	2	9		10					0			0	x
South Atlantic		2		2					0			0	0
North Central	1	1		2					0	x		x	2
South Central	x	x		x					0			0	0
Mountain													
Northwest	2			2					0	3		3	x
Alaska													
Southwest	3	4		7					0	15		15	1
TOTAL	8	16		24					0	19		19	3

x = 500 tons or less
figures rounded after adding

TABLE A3(con't) BEAN, LIMA

REGION	Total Raw tons, 1000
New England	
Mid Atlantic	5
South Atlantic	16
North Central	17
South Central	7
Mountain	2
Northwest	10
Alaska	
Southwest	58
TOTAL	115

Number of plants in survey sample	35
% of raw tons in survey sample	58 %
Estimated percent yield	86 %
Estimated total residuals	16,000 tons
Average raw tons/plant in survey sample	2,000 tons

RESIDUAL TONS BY MONTH AND REGION, 1000 tons

REGION	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
New England													
Mid Atlantic									2	1			3
South Atlantic								1	1				2
North Central								1	1	x	x	x	2
South Central								x	1	x			1
Mountain								x	x	x			x
Northwest						x	x	x	x	x			1
Alaska													
Southwest							x	3	4	3	x		10
TOTAL						x	x	5	8	5	x	x	19

RESIDUAL TONS BY DISPOSAL METHOD AND REGION, 1000 tons

	handled as solid waste				handled in liquid waste					by-products			Not. acct'd. for
REGION	fill	spread	burn	total	water	pond	sewer	irrig.	total	feed	other	total	1000 T
New England													
Mid Atlantic		3		3					0			0	-2
South Atlantic		2		2					0			0	0
North Central		2		2					0	x		x	0
South Central		1		1					0	x		x	0
Mountain				0					0	x		x	0
Northwest				0					0	1		1	0
Alaska													
Southwest	1	1		2					0	8		8	-1
TOTAL	1	8		10					0	10		10	-3

x = 500 tons or less
figures rounded after adding

TABLE A3 (con't) BEAN, SNAP

REGION	Total Raw tons, 1000
New England	10
Mid Atlantic	117
South Atlantic	61
North Central	131
South Central	68
Mountain	16
Northwest	174
Alaska	
Southwest	50
TOTAL	627

Number of plants in survey sample	58	
% of raw tons in survey sample	52	%
Estimated percent yield	79	%
Estimated total residuals	134,000	tons
Average raw tons/plant in survey sample	6,000	tons

RESIDUAL TONS BY MONTH AND REGION, 1000 tons

REGION	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
New England							1	1	1				2
Mid Atlantic						1	8	8	8	1			26
South Atlantic				1	2	2	2	x	x				8
North Central							8	12	10	3			34
South Central				1	1	1	1	1	2	3	1		10
Mountain							x	1	x				2
Northwest						1	14	14	11	1			41
Alaska													
Southwest						2	2	3	2	2			11
TOTAL				2	3	7	37	41	35	9	1		134

RESIDUAL TONS BY DISPOSAL METHOD AND REGION, 1000 tons

	handled as solid waste				handled in liquid waste					by-products			Not. acct'd. for
REGION	fill	spread	burn	total	water	pond	sewer	irrig.	total	feed	other	total	1000 T
New England	1	x		1					0	1		1	0
Mid Atlantic	13	6		19					0	8		8	1
South Atlantic	x	x		x			2		2	6		6	2
North Central	7	20		27					0	7		7	-1
South Central		4		4					0	6		6	1
Mountain	x	x		x					0	1		1	x
Northwest	11	1		13		x	1		1	27		27	-2
Alaska													
Southwest	3			3					0	8		8	0
TOTAL	35	32		67		x	3		3	64		64	0

x = 500 tons or less
figures rounded after adding

TABLE A3 (con't) BEET

REGION	Total Raw tons, 1000
New England	
Mid Atlantic	91
South Atlantic	2
North Central	100
South Central	27
Mountain	4
Northwest	44
Alaska	
Southwest	2
TOTAL	270

Number of plants in survey sample	17	
% of raw tons in survey sample	46	%
Estimated percent yield	59	%
Estimated total residuals	110,000	tons
Average raw tons/plant in survey sample	7,000	tons

RESIDUAL TONS BY MONTH AND REGION, 1000 tons

REGION	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
New England													
Mid Atlantic				2				2	2	6	6	2	19
South Atlantic								x	x	x	x		x
North Central							3	7	10	12	7		39
South Central	2				1	1						1	6
Mountain							1	1					2
Northwest							5	6	6	5	1		23
Alaska													
Southwest							x	x	x	x	x		1
TOTAL	2			2	1	1	9	16	18	22	14	3	90

RESIDUAL TONS BY DISPOSAL METHOD AND REGION, 1000 tons

	handled as solid waste				handled in liquid waste					by-products			Not. acct'd. for
REGION	fill	spread	burn	total	water	pond	sewer	irrig.	total	feed	other	total	1000 T
New England													
Mid Atlantic	6	13		19					0	x		x	11
South Atlantic	x	x		x					0			0	x
North Central	3	34		37					0	2		2	10
South Central				0					0	6		6	x
Mountain	1			1			1		1			0	0
Northwest	7			7			5		5	10		10	x
Alaska													
Southwest	x			x			x		x	x		x	0
TOTAL	18	46		65			6		6	18		18	21

x = 500 tons or less
figures rounded after adding

TABLE A3 (con't) BROCCOLI, SPROUTS, CAULIFLOWER

REGION	Total Raw tons, 1000
New England	
Mid Atlantic	10
South Atlantic	
North Central	1
South Central	2
Mountain	
Northwest	42
Alaska	
Southwest	200
TOTAL	255

Number of plants in survey sample	21
% of raw tons in survey sample	61 %
Estimated percent yield	56 %
Estimated total residuals	113,000 tons
Average raw tons/plant in survey sample	8,000 tons

RESIDUAL TONS BY MONTH AND REGION, 1000 tons

REGION	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
New England													
Mid Atlantic		x	1	1									2
South Atlantic													
North Central			x	x									x
South Central		x	x	x									x
Mountain													
Northwest								7	8	7	7		29
Alaska													
Southwest	7	5	6	6	6	7	5	5	5	9	9	10	81
TOTAL	7	6	7	7	6	7	5	13	13	16	16	10	113

RESIDUAL TONS BY DISPOSAL METHOD AND REGION, 1000 tons

	handled as solid waste				handled in liquid waste					by-products			Not. acct'd. for
REGION	fill	spread	burn	total	water	pond	sewer	irrig.	total	feed	other	total	1000 T
New England													
Mid Atlantic				0					0	2		2	0
South Atlantic													
North Central				0					0	x		x	0
South Central				0					0	x		x	0
Mountain													
Northwest		6		6					0	24		24	-1
Alaska													
Southwest	12	3		15			1		1	65		65	2
TOTAL	12	9		21			1		1	91		91	x

x = 500 tons or less
figures rounded after adding

TABLE A3 (con't) CABBAGE - SAUERKRAUT

REGION	Total Raw tons, 1000
New England	
Mid Atlantic	97
South Atlantic	13
North Central	86
South Central	9
Mountain	2
Northwest	25
Alaska	
Southwest	
TOTAL	232

Number of plants in survey sample	17	
% of raw tons in survey sample	45	%
Estimated percent yield	68	%
Estimated total residuals	75,000	tons
Average raw tons/plant in survey sample	6,000	tons

RESIDUAL TONS BY MONTH AND REGION, 1000 tons

REGION	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
New England													
Mid Atlantic	3	3	3	3	2	1		3	4	4	4	3	32
South Atlantic	x	1	x	x	x	x		x	1	1	x	x	4
North Central								4	7	8	6	1	27
South Central	1	1	x								x	1	3
Mountain								x	x	x			x
Northwest									3	3	3	2	10
Alaska													
Southwest													
TOTAL	4	4	4	3	2	1		8	14	16	14	7	76

RESIDUAL TONS BY DISPOSAL METHOD AND REGION, 1000 tons

	handled as solid waste				handled in liquid waste					by-products			Not. acct'd. for
REGION	fill	spread	burn	total	water	pond	sewer	irrig.	total	feed	other	total	1000 T
New England													
Mid Atlantic	5	22		27		5			5			0	2
South Atlantic	1	3		4		1			1			0	x
North Central	7	20		27					0			0	x
South Central				0					0	3		3	0
Mountain		x		x					0			0	0
Northwest	6			6					0	4		4	-3
Alaska													
Southwest													
TOTAL	19	44		64		6			6	6		6	-1

x = 500 tons or less
figures rounded after adding

TABLE A3 (con't) CARROT

REGION	Total Raw tons, 1000
New England	
Mid Atlantic	14
South Atlantic	7
North Central	110
South Central	10
Mountain	
Northwest	83
Alaska	
Southwest	60
TOTAL	284

Number of plants in survey sample	34	
% of raw tons in survey sample	67	%
Estimated percent yield	52	%
Estimated total residuals	148,000	tons
Average raw tons/plant in survey sample	6,000	tons

RESIDUAL TONS BY MONTH AND REGION, 1000 tons

REGION	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
New England													
Mid Atlantic										3	3		6
South Atlantic										2	1		3
North Central	1	1	1	1	2	2	6	7	13	10	3		47
South Central	x	x	x	1	x								2
Mountain													
Northwest	1								6	16	16	7	45
Alaska													
Southwest	3	2	3	3	2	3	3	3	4	3	3	4	36
TOTAL	6	3	4	5	4	5	9	10	23	33	26	12	139

RESIDUAL TONS BY DISPOSAL METHOD AND REGION, 1000 tons

	handled as solid waste				handled in liquid waste					by-products			Not. acct'd. for
REGION	fill	spread	burn	total	water	pond	sewer	irrig.	total	feed	other	total	1000 T
New England													
Mid Atlantic		6		6					0			0	0
South Atlantic		3		3					0			0	0
North Central	x	22		22					0	25		25	6
South Central				0					0	2		2	2
Mountain													
Northwest	5			5			2		2	37	x	37	1
Alaska													
Southwest				0					0	36		36	0
TOTAL	6	30		36			2		2	100	x	100	10

x = 500 tons or less
figures rounded after adding

TABLE A3 (con't) CORN

REGION	Total Raw tons, 1000
New England	10
Mid Atlantic	112
South Atlantic	91
North Central	1,498
South Central	10
Mountain	30
Northwest	729
Alaska	
Southwest	
TOTAL	2,480

Number of plants in survey sample	70	
% of raw tons in survey sample	52	%
Estimated percent yield	33	%
Estimated total residuals	1,664,000	tons
Average raw tons/plant in survey sample	18,000	tons

RESIDUAL TONS BY MONTH AND REGION, 1000 tons

REGION	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
New England								2	3	2			7
Mid Atlantic								28	28	18			73
South Atlantic							32	32					64
North Central							23	420	380	150			970
South Central						8							8
Mountain								7	8				15
Northwest							15	120	180	120	48		480
Alaska													
Southwest													
TOTAL						8	70	620	590	280	48		1,620

RESIDUAL TONS BY DISPOSAL METHOD AND REGION, 1000 tons

	handled as solid waste				handled in liquid waste					by-products			Not. acct'd. for
REGION	fill	spread	burn	total	water	pond	sewer	irrig.	total	feed	other	total	1000 T
New England		x		x					0	6		6	1
Mid Atlantic		4		4					0	69		69	8
South Atlantic		14		14					0	51		51	1
North Central	2	64	x	67			x	1	1	900		900	16
South Central				0					0	8		8	0
Mountain		2		2					0	13		13	4
Northwest	1	1		2			1	x	2	480		480	12
Alaska													
Southwest													
TOTAL	3	86	x	89			2	1	3	1,530		1,530	42

x = 500 tons or less
figures rounded after adding

TABLE A3 (con't) GREENS, SPINACH

REGION	Total Raw tons, 1000
New England	3
Mid Atlantic	10
South Atlantic	42
North Central	6
South Central	85
Mountain	
Northwest	11
Alaska	
Southwest	82
TOTAL	239

Number of plants in survey sample	29
% of raw tons in survey sample	48 %
Estimated percent yield	84 %
Estimated total residuals	37,000 tons
Average raw tons/plant in survey sample	4,000 tons

RESIDUAL TONS BY MONTH AND REGION, 1000 tons

REGION	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
New England	x		x	x	x					x	x	x	1
Mid Atlantic	x	x	x	x	x	x			x	x	x	x	2
South Atlantic	x	1	1	1	1	x			x	1	1	1	8
North Central						x			x				x
South Central	2	1	2	1	x				x	1	1	2	11
Mountain													
Northwest			x	1	x	x		x					1
Alaska													
Southwest			4	5	1	x		x	x	x			10
TOTAL	2	2	8	7	3	1		x	2	2	3	2	33

RESIDUAL TONS BY DISPOSAL METHOD AND REGION, 1000 tons

	handled as solid waste				handled in liquid waste					by-products			Not. acct'd. for
REGION	fill	spread	burn	total	water	pond	sewer	irrig.	total	feed	other	total	1000 T
New England	x	x		x					0	1		1	x
Mid Atlantic	x	x		x					0	1		1	x
South Atlantic	1	x		1		x			x	6		6	1
North Central				0					0	x		x	2
South Central		1		1					0	9		9	1
Mountain													
Northwest	x	x		1					0	1		1	0
Alaska													
Southwest	4	1		4			x		x	6		6	x
TOTAL	5	3		8		x	x		x	24		24	4

x = 500 tons or less
figures rounded after adding

TABLE A3 (con't) MUSHROOM

REGION	Total Raw tons, 1000
New England	1
Mid Atlantic	46
South Atlantic	6
North Central	8
South Central	
Mountain	
Northwest	2
Alaska	
Southwest	4
TOTAL	67

Number of plants in survey sample	5
% of raw tons in survey sample	19 %
Estimated percent yield	54 %
Estimated total residuals	31,000 tons
Average raw tons/plant in survey sample	3,000 tons

RESIDUAL TONS BY MONTH AND REGION, 1000 tons

REGION	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
New England	x	x									x	x	x
Mid Atlantic	2	2	2	1	1	1	1	x	1	1	2	2	16
South Atlantic	x	x	x	x	x	x	x	x	x	x	x	x	2
North Central	1	1	1	1	1	1	1	1	1	1	1	1	11
South Central													
Mountain													
Northwest	x	x	x	x					x	x	x	x	1
Alaska													
Southwest	x	x	x	x	x	x			x	x	x	x	2
TOTAL	3	3	3	3	3	3	2	2	2	3	3	3	32

RESIDUAL TONS BY DISPOSAL METHOD AND REGION, 1000 tons

	handled as solid waste				handled in liquid waste					by-products			Not. acct'd. for
REGION	fill	spread	burn	total	water	pond	sewer	irrig.	total	feed	other	total	1000 T
New England	x	x		x					0			0	x
Mid Atlantic	4	13		16					0			0	3
South Atlantic		2		2					0			0	0
North Central		11		11					0			0	-6
South Central													
Mountain													
Northwest	x	1		1					0			0	x
Alaska													
Southwest	x	1		2					0			0	x
TOTAL	4	28		32					0			0	-2

x = 500 tons or less
figures rounded after adding

TABLE A3 (con't) PEA

REGION	Total Raw tons, 1000
New England	8
Mid Atlantic	22
South Atlantic	40
North Central	289
South Central	10
Mountain	10
Northwest	183
Alaska	
Southwest	20
TOTAL	582

Number of plants in survey sample	71	
% of raw tons in survey sample	55	%
Estimated percent yield	87	%
Estimated total residuals	78,000	tons
Average raw tons/plant in survey sample	4,000	tons

RESIDUAL TONS BY MONTH AND REGION, 1000 tons

REGION	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
New England						2	2						4
Mid Atlantic						5	6						11
South Atlantic					2	2							4
North Central						10	14	6					30
South Central				x	x	1	1	1	1	1	x	x	6
Mountain						x	1	x					1
Northwest					1	4	6	4	x				15
Alaska													
Southwest				1	2								2
TOTAL				1	5	25	28	11	1	1	x	x	74

RESIDUAL TONS BY DISPOSAL METHOD AND REGION, 1000 tons

	handled as solid waste				handled in liquid waste					by-products			Not. acct'd.
REGION	fill	spread	burn	total	water	pond	sewer	irrig.	total	feed	other	total	for 1000 T
New England		x		x					0	4		4	x
Mid Atlantic		1		1					0	10		10	-1
South Atlantic		4		4					0			0	0
North Central	2	17		19					0	12		12	3
South Central				0					0	6		6	0
Mountain				0					0	1		1	1
Northwest		x		x					0	15	x	15	0
Alaska													
Southwest	1			1					0	2		2	1
TOTAL	3	22		24					0	49	x	49	4

x = 500 tons or less
figures rounded after adding

TABLE A3 (con't) POTATO, WHITE

REGION	Total Raw tons, 1000
New England	700
Mid Atlantic	80
South Atlantic	60
North Central	360
South Central	40
Mountain	10
Northwest	2,300
Alaska	
Southwest	20
TOTAL	3,570

Number of plants in survey sample	22	
% of raw tons in survey sample	26	%
Estimated percent yield	62	%
Estimated total residuals	1,340,000	tons
Average raw tons/plant in survey sample	42,000	tons

RESIDUAL TONS BY MONTH AND REGION, 1000 tons

REGION	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
New England	8	8	8	8	8	8	8	9	9	9	8	8	100
Mid Atlantic	1	1	1	1	1	1	1	1	1	1	1	1	11
South Atlantic	2		2	2	4	4	4	2	2				23
North Central	19	13	13	7	6	6	13	19	13	26	39	26	200
South Central							1	1					2
Mountain									1	1	1	1	4
Northwest	68	68	68	68	68	41	41	68	81	94	81	81	826
Alaska													
Southwest				1	2	1	1						5
TOTAL	99	90	92	86	90	62	69	100	106	130	130	117	1,170

RESIDUAL TONS BY DISPOSAL METHOD AND REGION, 1000 tons

	handled as solid waste				handled in liquid waste					by-products			Not. acct'd. for
REGION	fill	spread	burn	total	water	pond	sewer	irrig.	total	feed	other	total	1000 T
New England				0					0	100		100	165
Mid Atlantic	11			11					0			0	19
South Atlantic	3			3		x	4		4	15		15	4
North Central	18	4		23					0	177		177	-83
South Central				0					0	2		2	13
Mountain	x	x		1					0	3		3	0
Northwest	22	24		46	42	2			44	736		736	50
Alaska													
Southwest	2			2					0	3		3	3
TOTAL	57	28		85	42	2	4		48	1,037		1,037	171

x = 500 tons or less

figures rounded after adding

TABLE A3 (con't) PUMPKIN, SQUASH

REGION	Total Raw tons, 1000
New England	4
Mid Atlantic	2
South Atlantic	20
North Central	100
South Central	37
Mountain	5
Northwest	20
Alaska	
Southwest	36
TOTAL	224

Number of plants in survey sample	14	
% of raw tons in survey sample	60	%
Estimated percent yield	38	%
Estimated total residuals	152,000	tons
Average raw tons/plant in survey sample	9,000	tons

RESIDUAL TONS BY MONTH AND REGION, 1000 tons

REGION	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
New England								2					2
Mid Atlantic								1					1
South Atlantic								10					10
North Central									4	10	4		18
South Central									3	8	3		14
Mountain									x	x			x
Northwest							1	1	2	3	3		10
Alaska													
Southwest									1	1	1		3
TOTAL							1	12	10	22	10		55

RESIDUAL TONS BY DISPOSAL METHOD AND REGION, 1000 tons

	handled as solid waste				handled in liquid waste					by-products			Not. acct'd. for
REGION	fill	spread	burn	total	water	pond	sewer	irrig.	total	feed	other	total	1000 T
New England		x		x			2		2			0	0
Mid Atlantic		x		x			1		1			0	0
South Atlantic		2		2			9		9			0	0
North Central	x	6		7		x			x	10	1	10	74
South Central	x	5		6		x			x	8	1	8	0
Mountain	x			x					0	x		x	3
Northwest	4			4					0	6	x	6	0
Alaska													
Southwest	2			2					0	1		1	20
TOTAL	8	13		22		x	12		12	24	2	25	97

x = 500 tons or less

figures rounded after adding

TABLE A3 (con't) TOMATO

REGION	Total Raw tons, 1000
New England	
Mid Atlantic	591
South Atlantic	228
North Central	1,108
South Central	71
Mountain	65
Northwest	
Alaska	
Southwest	4,903
TOTAL	6,966

Number of plants in survey sample	58	
% of raw tons in survey sample	53	%
Estimated percent yield	90	%
Estimated total residuals	672,000	tons
Average raw tons/plant in survey sample	64,000	tons

RESIDUAL TONS BY MONTH AND REGION, 1000 tons

REGION	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
New England													
Mid Atlantic							8	18	18	12			57
South Atlantic	6	6	6	7	7	7			7			6	52
North Central								26	28	21			75
South Central								2	2	1			5
Mountain								8	10	10			29
Northwest													
Alaska													
Southwest						3	62	82	82	69	6		305
TOTAL	6	6	6	7	7	10	70	137	147	113	6	6	523

RESIDUAL TONS BY DISPOSAL METHOD AND REGION, 1000 tons

	handled as solid waste				handled in liquid waste					by-products			Not. acct'd. for
REGION	fill	spread	burn	total	water	pond	sewer	irrig.	total	feed	other	total	1000 T
New England													
Mid Atlantic	39	17		56		x			x	1		1	21
South Atlantic		34		34					0	18		18	12
North Central	27	20	x	47		5		1	6	22		22	26
South Central	2	1		3		x		x	x	1		1	2
Mountain	8			8		2	x		2	19		19	2
Northwest													
Alaska													
Southwest	171	59		230	21		x		21	53		54	87
TOTAL	246	131	x	377	21	7	x	1	30	116		116	149

x = 500 tons or less
figures rounded after adding

TABLE A3 (con't) VEGETABLE, MISC.

REGION	Total Raw tons, 1000
New England	
Mid Atlantic	60
South Atlantic	340
North Central	80
South Central	180
Mountain	20
Northwest	70
Alaska	
Southwest	470
TOTAL	1,220

Number of plants in survey sample	42
% of raw tons in survey sample	31 %
Estimated percent yield	78 %
Estimated total residuals	273,000 tons
Average raw tons/plant in survey sample	9,000 tons

RESIDUAL TONS BY MONTH AND REGION, 1000 tons

REGION	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
New England													
Mid Atlantic	3	3	3	1	1	3	1	3	3	5	4	3.	31
South Atlantic	2	2	2	2	2		8	15	13	11	10	4	72
North Central	1	1	1	1	4	2	1	1	1	5	6	1	26
South Central	3	4	4	4	4	6	8	8	7	7	6	4	64
Mountain						1	1	1	1				4
Northwest	1	1	1		x	1	1	1	1	1	1	x	8
Alaska													
Southwest	1	2	2	2	5	7	10	11	10	9	6	3	68
TOTAL	11	12	13	11	17	19	30	38	36	38	32	16	273

RESIDUAL TONS BY DISPOSAL METHOD AND REGION, 1000 tons

	handled as solid waste				handled in liquid waste					by-products			Not. acct'd. for
REGION	fill	spread	burn	total	water	pond	sewer	irrig.	total	feed	other	total	1000 T
New England													
Mid Atlantic	16	14		31					0			0	3
South Atlantic	9	7		16		1	49		50	6		6	4
North Central	x	13		14					0	13		13	1
South Central	8	8		16			x		x	47		47	x
Mountain				0					0	4		4	0
Northwest	3			3					0	6		6	x
Alaska													
Southwest	2	28	4	34			2		2	32		32	-7
TOTAL	38	71	4	113		1	52		52	107		107	x

x = 500 tons or less
figures rounded after adding

TABLE A3 (con't) APPLE

REGION	Total Raw tons, 1000
New England	23
Mid Atlantic	398
South Atlantic	224
North Central	170
South Central	2
Mountain	20
Northwest	50
Alaska	
Southwest	161
TOTAL	1,048

Number of plants in survey sample	26
% of raw tons in survey sample	14%
Estimated percent yield	70%
Estimated total residuals	319,000 tons
Average raw tons/plant in survey sample	6,000 tons

RESIDUAL TONS BY MONTH AND REGION, 1000 tons

REGION	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
New England	x	1	x	x				x	1	1	2	1	7
Mid Atlantic	8	11	8	4				4	15	19	27	19	114
South Atlantic	10								10	20	20	20	80
North Central	3	2	2	2	1			2	3	8	8	7	38
South Central													
Mountain									1	1	1	1	4
Northwest	2	2	1	1	1				x	1	2	2	11
Alaska													
Southwest	5	5	4	2	2				2	3	5	6	35
TOTAL	28	21	15	5	4			6	33	53	64	56	289

RESIDUAL TONS BY DISPOSAL METHOD AND REGION, 1000 tons

	handled as solid waste				handled in liquid waste					by-products			Not. acct'd. for
REGION	fill	spread	burn	total	water	pond	sewer	irrig.	total	feed	other	total	1000 T
New England	x	3		3					0		4	4	0
Mid Atlantic	2	50		52		x			x		62	62	-2
South Atlantic	4			4					0	76		76	0
North Central	18	1		19				x	x	x	18	19	19
South Central													
Mountain	x			x					0	4		4	2
Northwest	2			2					0	8	1	8	2
Alaska													
Southwest	8			8	x				x	24	3	27	8
TOTAL	35	54		90	x	x		x	x	112	87	199	30

x = 500 tons or less
figures rounded after adding

TABLE A3 (con't) APRICOT

REGION	Total Raw tons, 1000
New England	
Mid Atlantic	
South Atlantic	
North Central	
South Central	
Mountain	
Northwest	1
Alaska	
Southwest	114
TOTAL	115

Number of plants in survey sample	16
% of raw tons in survey sample	59%
Estimated percent yield	82%
Estimated total residuals	21,000 tons
Average raw tons/plant in survey sample	4,000 tons

RESIDUAL TONS BY MONTH AND REGION, 1000 tons

REGION	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
New England													
Mid Atlantic													
South Atlantic													
North Central													
South Central													
Mountain													
Northwest							x						x
Alaska													
Southwest	x	1	1	x		6	7						15
TOTAL	x	1	1	x		6	7						16

RESIDUAL TONS BY DISPOSAL METHOD AND REGION, 1000 tons

	handled as solid waste				handled in liquid waste					by-products			Not. acct'd. for
REGION	fill	spread	burn	total	water	pond	sewer	irrig.	total	feed	other	total	1000 T
New England													
Mid Atlantic													
South Atlantic													
North Central													
South Central													
Mountain													
Northwest	x			x					0			0	0
Alaska													
Southwest	4	2		6	x				x	7	2	9	5
TOTAL	4	2		6	x				x	7	2	9	5

x = 500 tons or less
figures rounded after adding

TABLE A3 (con't) BERRY

REGION	Total Raw tons, 1000
New England	32
Mid Atlantic	8
South Atlantic	1
North Central	28
South Central	
Mountain	
Northwest	97
Alaska	
Southwest	38
TOTAL	204

Number of plants in survey sample	38
% of raw tons in survey sample	31 %
Estimated percent yield	92 %
Estimated total residuals	15,000 tons
Average raw tons/plant in survey sample	2,000 tons

RESIDUAL TONS BY MONTH AND REGION, 1000 tons

REGION	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
New England								2	1				3
Mid Atlantic	x	x	x		x	x	x						1
South Atlantic													0
North Central						x	x	1	x				1
South Central													
Mountain													
Northwest						3	2	1	1	x			7
Alaska													
Southwest				x	x	1	x	x	x	x			2
TOTAL	x	x	x	x	x	3	3	4	2	x			14

RESIDUAL TONS BY DISPOSAL METHOD AND REGION, 1000 tons

	handled as solid waste				handled in liquid waste					by-products			Not. acct'd. for
REGION	fill	spread	burn	total	water	pond	sewer	irrig.	total	feed	other	total	1000 T
New England	x		1	1	2	x			2			0	x
Mid Atlantic		1		1					0			0	0
South Atlantic				0					0			0	0
North Central	1	x		1					0	x		x	x
South Central													
Mountain													
Northwest	2	4	x	6			x		x	1		1	x
Alaska													
Southwest	1			1			x		x	x		x	1
TOTAL	4	5	1	10	2	x	x		2	1		1	2

x = 500 tons or less
figures rounded after adding

TABLE A3 (con't) CHERRY

REGION	Total Raw tons, 1000
New England	
Mid Atlantic	26
South Atlantic	
North Central	123
South Central	
Mountain	9
Northwest	17
Alaska	
Southwest	12
TOTAL	187

Number of plants in survey sample	32	
% of raw tons in survey sample	30	%
Estimated percent yield	85	%
Estimated total residuals	27,000	tons
Average raw tons/plant in survey sample	2,000	tons

RESIDUAL TONS BY MONTH AND REGION, 1000 tons

REGION	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
New England													
Mid Atlantic							2	1					3
South Atlantic													
North Central							9	9					18
South Central													
Mountain							1	1					2
Northwest						1	1	x					2
Alaska													
Southwest					x	1							1
TOTAL					x	1	13	11					26

RESIDUAL TONS BY DISPOSAL METHOD AND REGION, 1000 tons

	handled as solid waste				handled in liquid waste					by-products			Not. acct'd. for
REGION	fill	spread	burn	total	water	pond	sewer	irrig.	total	feed	other	total	1000 T
New England													
Mid Atlantic	1	2		3					0			0	x
South Atlantic													
North Central	10	3	x	13				1	1	4		4	1
South Central													
Mountain	2			2					0			0	0
Northwest	1	x		2					0	x	x	1	x
Alaska													
Southwest	1			1					0	x		x	x
TOTAL	15	5	x	20				1	1	4	x	4	1

x = 500 tons or less
figures rounded after adding

TABLE A3 (con't) CITRUS

REGION	Total Raw tons, 1000
New England	
Mid Atlantic	
South Atlantic	6,534
North Central	
South Central	189
Mountain	
Northwest	
Alaska	
Southwest	1,074
TOTAL	7,797

Number of plants in survey sample	7	
% of raw tons in survey sample	18	%
Estimated percent yield	56	%
Estimated total residuals	3,388,000	tons
Average raw tons/plant in survey sample	200,000	tons

RESIDUAL TONS BY MONTH AND REGION, 1000 tons

REGION	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
New England													
Mid Atlantic													
South Atlantic	280	290	290	280	280	280	170	60	60	110	170	280	2,550
North Central													
South Central	8	8	9	8	8	8	5	2	2	3	5	8	74
Mountain													
Northwest													
Alaska													
Southwest	45	45	45	44	44	44	44	44	44	44	45	45	533
TOTAL	328	328	328	327	327	327	214	101	101	158	215	328	3,083

RESIDUAL TONS BY DISPOSAL METHOD AND REGION, 1000 tons

	handled as solid waste				handled in liquid waste					by-products			Not. acct'd. for
REGION	fill	spread	burn	total	water	pond	sewer	irrig.	total	feed	other	total	1000 T
New England													
Mid Atlantic													
South Atlantic	4	76		80				x	x	2,470	3	2,470	300
North Central													
South Central		3		3					0	71		71	8
Mountain													
Northwest													
Alaska													
Southwest				0				1	1	530		530	5
TOTAL	4	79		83				1	1	3,000	3	3,000	3.3

x = 500 tons or less
figures rounded after adding

TABLE A3 (con't) FRUIT, MISC.

REGION	Total Raw tons, 1000
New England	5
Mid Atlantic	20
South Atlantic	5
North Central	20
South Central	10
Mountain	
Northwest	10
Alaska	
Southwest	80
TOTAL	150

Number of plants in survey sample	24	
% of raw tons in survey sample	58	%
Estimated percent yield	74	%
Estimated total residuals	39,000	tons
Average raw tons/plant in survey sample	4,000	tons

RESIDUAL TONS BY MONTH AND REGION, 1000 tons

REGION	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
New England										1	x		1
Mid Atlantic										2	1		3
South Atlantic										1	x		1
North Central							x	x	1	1	x	x	3
South Central	x	x	x	1	1	1	1	x	x	x	x	x	5
Mountain													
Northwest								x	1	1			2
Alaska													
Southwest						2	4	6	7	3			21
TOTAL	x	x	x	1	1	3	4	8	9	8	2	1	36

RESIDUAL TONS BY DISPOSAL METHOD AND REGION, 1000 tons

	handled as solid waste				handled in liquid waste					by-products			Not. acct'd. for
REGION	fill	spread	burn	total	water	pond	sewer	irrig.	total	feed	other	total	1000 T
New England		1		1					0			0	x
Mid Atlantic		2		2					0			0	x
South Atlantic		1		1					0			0	x
North Central	2	2		3					0			0	x
South Central	2			2					0	3		3	x
Mountain													
Northwest		2		2					0			0	0
Alaska													
Southwest	9	4		14			x		x	5	2	7	2
TOTAL	13	13		25			x		x	8	2	10	3

x = 500 tons or less
figures rounded after adding

TABLE A3 (con't) OLIVE

REGION	Total Raw tons, 1000
New England	
Mid Atlantic	
South Atlantic	
North Central	
South Central	
Mountain	
Northwest	
Alaska	
Southwest	85
TOTAL	85

Number of plants in survey sample	9	
% of raw tons in survey sample	82	%
Estimated percent yield	86	%
Estimated total residuals	12,000	tons
Average raw tons/plant in survey sample	8,000	tons

RESIDUAL TONS BY MONTH AND REGION, 1000 tons

REGION	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
New England													
Mid Atlantic													
South Atlantic													
North Central													
South Central													
Mountain													
Northwest													
Alaska													
Southwest	1	1	x		x	x	x		2	3	3	x	11
TOTAL	1	1	x		x	x	x		2	3	3	x	11

RESIDUAL TONS BY DISPOSAL METHOD AND REGION, 1000 tons

	handled as solid waste				handled in liquid waste					by-products			Not. acct'd. for
REGION	fill	spread	burn	total	water	pond	sewer	irrig.	total	feed	other	total	1000 T
New England													
Mid Atlantic													
South Atlantic													
North Central													
South Central													
Mountain													
Northwest													
Alaska													
Southwest	x	1	x	2		x			x		10	10	x
TOTAL	x	1	x	2		x			x		10	10	x

x = 500 tons or less
figures rounded after adding

TABLE A3 (con't) PEACH

REGION	Total Raw tons, 1000
New England	
Mid Atlantic	6
South Atlantic	81
North Central	3
South Central	
Mountain	14
Northwest	13
Alaska	
Southwest	981
TOTAL	1,098

Number of plants in survey sample	37
% of raw tons in survey sample	63 %
Estimated percent yield	75 %
Estimated total residuals	273,000 tons
Average raw tons/plant in survey sample	19,000 tons

RESIDUAL TONS BY MONTH AND REGION, 1000 tons

REGION	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
New England													
Mid Atlantic						1	1	1					3
South Atlantic						19	10	10					38
North Central								1	x				1
South Central													
Mountain									3				3
Northwest									2				2
Alaska													
Southwest						3	74	88	77	3			245
TOTAL						23	84	99	83	3			292

RESIDUAL TONS BY DISPOSAL METHOD AND REGION, 1000 tons

	handled as solid waste				handled in liquid waste					by-products			Not. acct'd. for
REGION	fill	spread	burn	total	water	pond	sewer	irrig.	total	feed	other	total	1000 T
New England													
Mid Atlantic	2	x		2					0	1		1	x
South Atlantic	28	3		30		x			x	7		7	-2
North Central	1	x		1				x	x			0	0
South Central													
Mountain	2			2					0	x		x	1
Northwest	2			2					0	x		x	1
Alaska													
Southwest	94	53		147	13		1		14	41	44	85	-19
TOTAL	129	56		185	13	x	1	x	14	50	44	94	-19

x = 500 tons or less
figures rounded after adding

TABLE A3 (con't) PEAR

REGION	Total Raw tons, 1000
New England	
Mid Atlantic	1
South Atlantic	
North Central	9
South Central	
Mountain	1
Northwest	115
Alaska	
Southwest	280
TOTAL	406

Number of plants in survey sample	24
% of raw tons in survey sample	64 %
Estimated percent yield	67 %
Estimated total residuals	132,000 tons
Average raw tons/plant in survey sample	11,000 tons

RESIDUAL TONS BY MONTH AND REGION, 1000 tons

REGION	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
New England													
Mid Atlantic								x	x	x	x		x
South Atlantic													
North Central								1	1	1	x		3
South Central													
Mountain								x	x	x	x		x
Northwest								11	13	11	5		40
Alaska													
Southwest							14	22	24	14			74
TOTAL							14	33	39	25	6		118

RESIDUAL TONS BY DISPOSAL METHOD AND REGION, 1000 tons

	handled as solid waste				handled in liquid waste					by-products			Not. acct'd. for
REGION	fill	spread	burn	total	water	pond	sewer	irrig.	total	feed	other	total	1000 T
New England													
Mid Atlantic	x			x					0			0	0
South Atlantic													
North Central	3			3					0			0	0
South Central													
Mountain	x	x		x					0	x		x	0
Northwest	24	8		32			x		x	8		8	4
Alaska													
Southwest	13	24		36	10				10	28		28	11
TOTAL	40	32		72	10		x		10	36		36	14

x = 500 tons or less
figures rounded after adding

TABLE A3 (con't) PINEAPPLE

REGION	Total Raw tons, 1000
New England	
Mid Atlantic	
South Atlantic	
North Central	
South Central	
Mountain	
Northwest	
Alaska	
Southwest	900
TOTAL	900

Number of plants in survey sample	-	
% of raw tons in survey sample	37	%
Estimated percent yield	55	%
Estimated total residuals	405,000	tons
Average raw tons/plant in survey sample	-	tons

RESIDUAL TONS BY MONTH AND REGION, 1000 tons

REGION	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
New England													
Mid Atlantic													
South Atlantic													
North Central													
South Central													
Mountain													
Northwest													
Alaska													
Southwest	25	25	30	50	55	55	55	55	30	25			405
TOTAL	25	25	30	50	55	55	55	55	30	25			405

RESIDUAL TONS BY DISPOSAL METHOD AND REGION, 1000 tons

	handled as solid waste				handled in liquid waste					by-products			Not. acct'd. for
REGION	fill	spread	burn	total	water	pond	sewer	irrig.	total	feed	other	total	1000 T
New England													
Mid Atlantic													
South Atlantic													
North Central													
South Central													
Mountain													
Northwest													
Alaska													
Southwest	30			30	5		5		10	365		365	0
TOTAL	30			30	5		5		10	365		365	0

x = 500 tons or less
figures rounded after adding

TABLE A3 (con't) PLUM, PRUNE

REGION	Total Raw tons, 1000
New England	
Mid Atlantic	2
South Atlantic	1
North Central	10
South Central	
Mountain	
Northwest	10
Alaska	
Southwest	5
TOTAL	27

Number of plants in survey sample	22	
% of raw tons in survey sample	75	%
Estimated percent yield	72	%
Estimated total residuals	8,000	tons
Average raw tons/plant in survey sample	1,000	tons

RESIDUAL TONS BY MONTH AND REGION, 1000 tons

REGION	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
New England													
Mid Atlantic	x	x	x	x						x			1
South Atlantic								x					x
North Central	x	x	x	x		x			1	1	x	x	3
South Central													
Mountain													
Northwest								x	1	x			1
Alaska													
Southwest	x	x	x			1	x						2
TOTAL	x	1	1	x		1	x	x	1	1	x	x	7

RESIDUAL TONS BY DISPOSAL METHOD AND REGION, 1000 tons

	handled as solid waste				handled in liquid waste					by-products			Not. acct'd. for 1000 T
REGION	fill	spread	burn	total	water	pond	sewer	irrig.	total	feed	other	total	
New England													
Mid Atlantic	1			1					0			0	x
South Atlantic		x		x					0			0	0
North Central	1	2		3					0			0	x
South Central													
Mountain													
Northwest	x	x		x					0	x		x	x
Alaska													
Southwest	1	x		1	1				1			0	x
TOTAL	4	2		6	1				1	x		x	1

x = 500 tons or less
figures rounded after adding

TABLE A3 (con't) BEAN, DRY

REGION	Total Raw tons, 1000
New England	40
Mid Atlantic	20
South Atlantic	10
North Central	90
South Central	30
Mountain	10
Northwest	10
Alaska	
Southwest	20
TOTAL	230

Number of plants in survey sample	17	
% of raw tons in survey sample	20	%
Estimated percent yield	97	%
Estimated total residuals	7,000	tons
Average raw tons/plant in survey sample	3,000	tons

RESIDUAL TONS BY MONTH AND REGION, 1000 tons

REGION	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
New England		x											x
Mid Atlantic	x	x	x	x		x		x		x	x	x	1
South Atlantic	x	x	x	x							x	x	x
North Central	1	1	x	x	x	x	x		x	x	x	1	3
South Central	x	x	x	x	x	x	x	x	x	x	x	x	2
Mountain			x	x									x
Northwest	x		x	x									x
Alaska													
Southwest	x	x	x	x								x	x
TOTAL	1	1	1	1	x	x	x	x	x	1	1	1	7

RESIDUAL TONS BY DISPOSAL METHOD AND REGION, 1000 tons

	handled as solid waste				handled in liquid waste					by-products			Not. acct'd. for
REGION	fill	spread	burn	total	water	pond	sewer	irrig.	total	feed	other	total	1000 T
New England	x			x					0			0	x
Mid Atlantic	1	x	x	1					0			0	x
South Atlantic	x			x					0	x		x	x
North Central	1	2		3					0			0	0
South Central				0					0	2		2	x
Mountain	x			x					0			0	0
Northwest	x			x					0			0	x
Alaska													
Southwest	x			x			x		x			0	x
TOTAL	3	2	x	6			x		x	2		2	-1

x = 500 tons or less
figures rounded after adding

TABLE A3 (con't) PICKLES

REGION	Total Raw tons, 1000
New England	7
Mid Atlantic	11
South Atlantic	132
North Central	216
South Central	79
Mountain	27
Northwest	19
Alaska	
Southwest	64
TOTAL	555

Number of plants in survey sample	6	
% of raw tons in survey sample	9	%
Estimated percent yield	95	%
Estimated total residuals	26,000	tons
Average raw tons/plant in survey sample	8,000	tons

RESIDUAL TONS BY MONTH AND REGION, 1000 tons

REGION	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
New England						x	x						x
Mid Atlantic						x	x						x
South Atlantic	x	x	x	x	x	x	x	x		x	x	x	3
North Central						4	5	5	4	4			22
South Central						1	2	2	2	1			8
Mountain						x	1	1	1				3
Northwest						x	1	x	x				2
Alaska													
Southwest						x	1	1	1				3
TOTAL	x	x	x	x	x	8	9	8	8	6	x	x	41

RESIDUAL TONS BY DISPOSAL METHOD AND REGION, 1000 tons

	handled as solid waste				handled in liquid waste					by-products			Not. acct'd. for
REGION	fill	spread	burn	total	water	pond	sewer	irrig.	total	feed	other	total	1000 T
New England	x			x					0			0	0
Mid Atlantic	x			x					0			0	0
South Atlantic	3			3					0			0	x
North Central	22			22					0			0	-11
South Central	8			8					0			0	-4
Mountain	2			2			x		x			0	0
Northwest	1			1			x		x			0	0
Alaska													
Southwest		3		3					0			0	0
TOTAL	37	3		40			1		1			0	-15

x = 500 tons or less

figures rounded after adding

TABLE A3 (con't) SPECIALTIES

REGION	Total Raw tons, 1000
New England	30
Mid Atlantic	180
South Atlantic	350
North Central	1,300
South Central	230
Mountain	
Northwest	60
Alaska	
Southwest	350
TOTAL	2,500

Number of plants in survey sample	38	
% of raw tons in survey sample	71	%
Estimated percent yield	-	%
Estimated total residuals	300,000	tons
Average raw tons/plant in survey sample	45,000	tons

RESIDUAL TONS BY MONTH AND REGION, 1000 tons

REGION	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
New England	x	x	x	x	1	1	1	1	x	x	x	x	6
Mid Atlantic	2	2	2	2	2	2	1	1	1	2	2	2	22
South Atlantic	4	4	4	4	4	3	3	3	3	4	4	4	45
North Central	12	12	12	12	11	11	11	11	12	12	12	12	140
South Central	2	2	2	2	2	3	3	3	3	3	3	2	30
Mountain													
Northwest	x	x	x	1	1	1	1	1	1	1	1	x	8
Alaska													
Southwest	4	4	4	4	4	4	4	4	4	4	4	4	49
TOTAL	26	26	26	26	25	24	23	24	24	25	25	26	300

RESIDUAL TONS BY DISPOSAL METHOD AND REGION, 1000 tons

	handled as solid waste				handled in liquid waste					by-products			Not. acct'd. for
REGION	fill	spread	burn	total	water	pond	sewer	irrig.	total	feed	other	total	1000 T
New England	x			x					0		5	5	-
Mid Atlantic	5			5			x		x	14	3	17	-
South Atlantic	12			12			x	x	x	30	2	33	-
North Central	13	3	8	24		7	13	x	19	97	x	97	-
South Central	3			3			4		4	20	1	21	-
Mountain													
Northwest	x			x					0	7	1	8	-
Alaska													
Southwest	3		x	3					0	41	4	45	-
TOTAL	37	3	8	48		7	18	x	24	211	17	227	-

x = 500 tons or less
figures rounded after adding

TABLE A3 (con't) CLAM, SCALLOP

REGION	Total Raw tons, 1000
New England	2
Mid Atlantic	80
South Atlantic	5
North Central	
South Central	
Mountain	
Northwest	
Alaska	3
Southwest	
TOTAL	90

Number of plants in survey sample	-	
% of raw tons in survey sample	10	%
Estimated percent yield	13	%
Estimated total residuals	78,000	tons
Average raw tons/plant in survey sample	-	tons

RESIDUAL TONS BY MONTH AND REGION, 1000 tons

REGION	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
New England													x
Mid Atlantic	1	1	1	1	x	x	x	x	x	1	1	1	8
South Atlantic	x	x	x	x	x	x	x	x	x	x	x	x	4
North Central													
South Central													
Mountain													
Northwest													
Alaska						x	x	x					x
Southwest													
TOTAL	1	1	1	1	1	1	1	1	1	1	1	1	13

RESIDUAL TONS BY DISPOSAL METHOD AND REGION, 1000 tons

	handled as solid waste				handled in liquid waste					by-products			Not acct'd. for
REGION	fill	spread	burn	total	water	pond	sewer	irrig.	total	feed	other	total	1000 T
New England	x			x					0			0	2
Mid Atlantic	8			8					0			0	61
South Atlantic		4		4					0			0	0
North Central													
South Central													
Mountain													
Northwest													
Alaska				0	x				x			0	2
Southwest													
TOTAL	8	4		12	x				x			0	65

x = 500 tons or less
figures rounded after adding

TABLE A3, (con't) OYSTER

REGION	Total Raw tons, 1000
New England	
Mid Atlantic	
South Atlantic	10
North Central	
South Central	5
Mountain	
Northwest	5
Alaska	
Southwest	
TOTAL	20

Number of plants in survey sample	-	
% of raw tons in survey sample	50	%
Estimated percent yield	10	%
Estimated total residuals	18,000	tons
Average raw tons/plant in survey sample	-	tons

RESIDUAL TONS BY MONTH AND REGION, 1000 tons

REGION	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
New England													
Mid Atlantic													
South Atlantic	2	1	1	1						1	1	2	9
North Central													
South Central	1	1	x	x						x	1	1	4
Mountain													
Northwest	1	1	1	x	x					x	x	1	5
Alaska													
Southwest													
TOTAL	3	3	3	2	x					2	2	3	18

RESIDUAL TONS BY DISPOSAL METHOD AND REGION, 1000 tons

	handled as solid waste				handled in liquid waste					by-products			Not. acct'd. for
REGION	fill	spread	burn	total	water	pond	sewer	irrig.	total	feed	other	total	1000 T
New England													
Mid Atlantic													
South Atlantic				0	1				1		8	8	x
North Central													
South Central				0	1				1		4	4	0
Mountain													
Northwest				0					0		5	5	0
Alaska													
Southwest													
TOTAL				0	2				2		16	16	x

x = 500 tons or less
figures rounded after adding

TABLE A3 (con't) CRAB

REGION	Total Raw tons, 1000
New England	
Mid Atlantic	
South Atlantic	2
North Central	
South Central	
Mountain	
Northwest	8
Alaska	20
Southwest	
TOTAL	30

Number of plants in survey sample	13	
% of raw tons in survey sample	55	%
Estimated percent yield	23	%
Estimated total residuals	23,000	tons
Average raw tons/plant in survey sample	1,000	tons

RESIDUAL TONS BY MONTH AND REGION, 1000 tons

REGION	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
New England													
Mid Atlantic													
South Atlantic	x	x	x	x	x	x	x	x	x			x	1
North Central													
South Central													
Mountain													
Northwest	1	1	1	1	1	x	x	x	x			1	6
Alaska	1	1	1	1	x	2	1	1	2	2	2	1	15
Southwest													
TOTAL	2	2	2	2	1	2	1	2	2	2	2	2	22

RESIDUAL TONS BY DISPOSAL METHOD AND REGION, 1000 tons

REGION	handled as solid waste				handled in liquid waste					by-products			Not. acct'd. for 1000 T
	fill	spread	burn	total	water	pond	sewer	irrig.	total	feed	other	total	
New England													
Mid Atlantic													
South Atlantic	1	x		1	x				x			0	x
North Central													
South Central													
Mountain													
Northwest	4	1		5	1				1			0	1
Alaska				0	15				15			0	0
Southwest													
TOTAL	5	1		6	16				16			0	1

x = 500 tons or less
figures rounded after adding

TABLE A3 (con't) SHRIMP

REGION	Total Raw tons, 1000
New England	40
Mid Atlantic	
South Atlantic	
North Central	
South Central	80
Mountain	
Northwest	
Alaska	2
Southwest	
TOTAL	122

Number of plants in survey sample	10	
% of raw tons in survey sample	7	%
Estimated percent yield	30	%
Estimated total residuals	85,000	tons
Average raw tons/plant in survey sample	1,000	tons

RESIDUAL TONS BY MONTH AND REGION, 1000 tons

REGION	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
New England	3	6	6	3	3								22
Mid Atlantic													
South Atlantic													
North Central													
South Central	2	1	1	3	4	5	5	5	5	5	4	4	43
Mountain													
Northwest													
Alaska	x	x			x	x						x	1
Southwest													
TOTAL	5	7	7	6	8	5	5	5	5	5	4	5	66

RESIDUAL TONS BY DISPOSAL METHOD AND REGION, 1000 tons

	handled as solid waste				handled in liquid waste					by-products			Not. acct'd. for
REGION	fill	spread	burn	total	water	pond	sewer	irrig.	total	feed	other	total	1000 T
New England				0	21				21		x	x	8
Mid Atlantic													
South Atlantic													
North Central													
South Central		4	3	7	7		12		19	16		16	11
Mountain													
Northwest													
Alaska				0	1				1			0	1
Southwest													
TOTAL		4	3	7	29		12		41	16	x	17	20

x = 500 tons or less
figures rounded after adding

TABLE A3 (con't) SALMON

REGION	Total Raw tons, 1000
New England	
Mid Atlantic	
South Atlantic	
North Central	
South Central	
Mountain	
Northwest	8
Alaska	116
Southwest	
TOTAL	124

Number of plants in survey sample	17	
% of raw tons in survey sample	37	%
Estimated percent yield	65	%
Estimated total residuals	44,000	tons
Average raw tons/plant in survey sample	3,000	tons

RESIDUAL TONS BY MONTH AND REGION, 1000 tons

REGION	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
New England													
Mid Atlantic													
South Atlantic													
North Central													
South Central													
Mountain													
Northwest	x	x	x	x	x	x	x	x	x	x	x		2
Alaska						8	12	10	8	2			39
Southwest													
TOTAL	x	x	x	x	x	8	12	10	8	2	x		40

RESIDUAL TONS BY DISPOSAL METHOD AND REGICN, 1000 tons

	handled as solic waste				handled in liquid waste					by-products			Not. acct'd. for
REGION	fill	spread	burn	total	water	pond	sewer	irrig.	total	feed	other	total	1000 T
New England													
Mid Atlantic													
South Atlantic													
North Central													
South Central													
Mountain													
Northwest				0	1				1	1	x	1	x
Alaska				0	34				34	3	2	5	3
Southwest													
TOTAL					35				35	4	2	6	3

x = 500 tons or less
figures rounded after adding

TABLE A3 (con't) SARDINE

REGION	Total Raw tons, 1000
New England	26
Mid Atlantic	
South Atlantic	
North Central	
South Central	
Mountain	
Northwest	
Alaska	
Southwest	
TOTAL	26

Number of plants in survey sample	6	
% of raw tons in survey sample	52	%
Estimated percent yield	75	%
Estimated total residuals	6,000	tons
Average raw tons/plant in survey sample	2,000	tons

RESIDUAL TONS BY MONTH AND REGION, 1000 tons

REGION	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
New England	x	x	1	1	x	1	1	1	1	x	x	x	6
Mid Atlantic													
South Atlantic													
North Central													
South Central													
Mountain													
Northwest													
Alaska													
Southwest													
TOTAL	x	x	1	1	x	1	1	1	1	x	x	x	6

RESIDUAL TONS BY DISPOSAL METHOD AND REGION, 1000 tons

REGION	handled as solid waste				handled in liquid waste					by-products			Not. acct'd. for 1000 T
	fill	spread	burn	total	water	pond	sewer	irrig.	total	feed	other	total	
New England				0					0		6	6	x
Mid Atlantic													
South Atlantic													
North Central													
South Central													
Mountain													
Northwest													
Alaska													
Southwest													
TOTAL				0					0		6	6	x

x = 500 tons or less
figures rounded after adding

TABLE A3 (con't) TUNA, MISC. SEAFOOD

REGION	Total Raw tons, 1000
New England	35
Mid Atlantic	30
South Atlantic	30
North Central	10
South Central	35
Mountain	
Northwest	170
Alaska	20
Southwest	195
TOTAL	525

Number of plants in survey sample	6
% of raw tons in survey sample	8 %
Estimated percent yield	64 %
Estimated total residuals	190,000 tons
Average raw tons/plant in survey sample	7,000 tons

RESIDUAL TONS BY MONTH AND REGION, 1000 tons

REGION	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
New England	x	x	x	x	x	x	1	1	1	1	x	x	5
Mid Atlantic	x	x	x	x	x	x	x	x	1	x	x	x	4
South Atlantic	x	x	x	x	x	x	x	x	1	x	x	x	4
North Central			x	x	x	x	x	x	x	x	x		1
South Central	x	x	x	x	x	x	1	1	1	1	1	x	5
Mountain													
Northwest	1	1	2	2	2	2	2	3	3	2	2	2	25
Alaska					1	1	1						2
Southwest	4	4	4	4	4	4	4	5	5	5	4	4	53
TOTAL	7	7	7	7	8	8	9	10	10	9	9	7	99

RESIDUAL TONS BY DISPOSAL METHOD AND REGION, 1000 tons

	handled as solid waste				handled in liquid waste					by-products			Not. acct'd. for
REGION	fill	spread	burn	total	water	pond	sewer	irrig.	total	feed	other	total	1000 T
New England				0					0	4	1	5	9
Mid Atlantic				0					0	3	1	4	9
South Atlantic				0					0	3	1	4	9
North Central				0					0	1		1	3
South Central				0					0	4	1	5	9
Mountain													
Northwest				0					0	19	6	25	47
Alaska				0					0		2	2	0
Southwest				0	x				x	35	18	53	5
TOTAL				0	x				x	69	30	99	91

x = 500 tons or less
figures rounded after adding

TABLE A3 (con't) TOTAL FOOD RESIDUALS

REGION	Total Raw tons, 1000
New England	980
Mid Atlantic	2,060
South Atlantic	8,320
North Central	5,890
South Central	1,220
Mountain	240
Northwest	4,310
Alaska	160
Southwest	10,310
TOTAL	33,490

Number of plants in survey sample	417
% of raw tons in survey sample	39 %
Estimated percent yield	70 %
Estimated total residuals	10,310,000 tons
Average raw tons/plant in survey sample	31,000 tons

RESIDUAL TONS BY MONTH AND REGION, 1000 tons

REGION	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
New England	13	17	17	13	13	12	13	18	15	13	12	11	170
Mid Atlantic	19	24	22	20	13	18	30	72	83	77	50	32	460
South Atlantic	311	300	302	303	306	323	231	133	95	154	210	321	2,990
North Central	38	31	30	24	25	39	96	538	488	271	87	50	1,720
South Central	22	19	20	22	24	35	25	24	28	34	26	24	300
Mountain			x	x		2	4	21	25	13	2	2	69
Northwest	75	74	74	75	76	55	92	244	319	263	170	96	1,610
Alaska	2	1	1	1	1	10	13	11	10	4	2	2	57
Southwest	96	94	102	131	136	149	251	332	304	199	87	78	2,010
TOTAL	570	550	560	580	590	700	860	1,400	1,330	920	640	600	9,310

RESIDUAL TONS BY DISPOSAL METHOD AND REGION, 1000 tons

	handled as solid waste				handled in liquid waste					by-products			Not. acct'd. for
REGION	fill	spread	burn	total	water	pond	sewer	irrig.	total	feed	other	total	1000 T
New England	3	5	1	9	23	x	2		25	115	16	130	180
Mid Atlantic	116	164	x	280		6	1		7	109	65	170	130
South Atlantic	66	157		220	2	2	64	x	68	2,690	14	2,700	330
North Central	141	247	9	400	x	12	13	3	28	1,274	20	1,300	62
South Central	23	28	3	54	8	x	17	x	25	215	7	220	43
Mountain	16	3		20		2	2		3	46		46	13
Northwest	102	48	x	150	43	2	11	x	57	1,393	13	1,410	110
Alaska				0	50				50	3	4	7	6
Southwest	365	184	4	550	50	x	10	1	61	1,308	83	1,390	130
TOTAL	830	830	18	1,680	180	24	120	5	320	7,080	220	7,300	1,010

x = 500 tons or less
figures rounded after adding

TABLE A3 (con't) NON-FOOD

REGION	(Food) Total Raw tons, 1000
New England	980
Mid Atlantic	2,060
South Atlantic	8,320
North Central	5,890
South Central	1,220
Mountain	240
Northwest	4,310
Alaska	160
Southwest	10,310
TOTAL	33,490

Number of plants in survey sample	178 reporting non-food
% of raw tons in survey sample	24 % of food raw tons
Estimated percent yield	-%
Estimated total residuals	-tons
Average raw tons/plant in survey sample	41,000 tons

NON-FOOD RESIDUAL TONS BY MONTH AND REGION, 1000 tons

REGION	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
New England	x	x	1	1	x	1	1	1	1	x	x	x	6
Mid Atlantic	10	10	10	8	9	6	9	13	11	14	10	10	120
South Atlantic	6	6	6	6	6	6	5	6	6	5	5	7	69
North Central	7	7	7	6	6	14	19	22	22	17	10	9	147
South Central	6	6	6	6	6	6	6	6	6	6	6	6	74
Mountain						x	x	1	x	x	x	x	2
Northwest	5	5	4	5	6	10	11	11	14	13	10	6	98
Alaska						x	x	x	x	x	x		1
Southwest	5	3	7	11	10	12	18	18	18	17	8	5	132
TOTAL	39	38	40	43	43	55	69	76	79	73	50	43	650

NON-FOOD RESIDUAL TONS BY DISPOSAL METHOD AND REGION, 1000 tons

	handled as solid waste				handled in liquid waste					by-products			Not. acct'd. for
REGION	fill	spread	burn	total	water	pond	sewer	irrig.	total	metal	other	total	1000 T
New England	3		2	6					0			0	-
Mid Atlantic	16		1	17					0	68	34	102	-
South Atlantic	26		38	64					0	6		6	-
North Central	81		17	98					0	27	21	48	-
South Central	42		8	50					0	21	4	25	-
Mountain	2		x	2					0			0	-
Northwest	53		12	65		32			32	x	x	1	-
Alaska	x	x	x	1	x				x			0	-
Southwest	78	17	17	112					0	12	8	20	-
TOTAL	300	17	97	414	x	32			32	134	67	201	-

x = 500 tons or less
figures rounded after adding

APPENDIX C

QUESTIONNAIRE AND SITE VISIT FORMS

Questionnaire. A large majority of the 421 returned questionnaires were nearly complete, but some omissions occurred. Some questions produced a higher percentage of useful information than did others. Examples of differing interpretations of the questions were:

> ''Yield %'' in the last column of page 2 appears to be adequately defined under ''Instructions,'' but an occasional response was impossible. Probably the number of cases of finished product per ton of raw commodity was listed, since this is a common interpretation of ''yield'' in the industry.
>
> Respondents generally neglected to itemize specific sources of residuals per ''Instructions'' on pages 3 and 5. This information included in the report was developed during the site visit phase of the program. Many respondents omitted non-food wastes on pages 3 and 7.
>
> The questions on disposal in the plant liquid effluent (page 8) were differently interpreted by different respondents. Some wrote in minute quantities that may have been estimates of dissolved and/or of finely divided suspended solids. Many omitted any answer, presumably implying that no significant weight of waste was disposed of in a liquid effluent.
>
> The questions on problems associated with on-site storage (page 9) or with disposal (pages 10 and 11) were sometimes left blank. The blanks could have indicated either that there were no problems or that no problems were known.

Budget Bureau Number 85- S 69009 Approval Expires December 1970

SOLID WASTE MANAGEMENT IN THE FOOD PROCESSING INDUSTRY

QUESTIONNAIRE

DISTRIBUTED BY THE NATIONAL CANNERS ASSOCIATION
1133 20th STREET, N.W. - WASHINGTON, D. C. 20036

NCA OFFICE USE ONLY

COMPANY	PLANT	
ADDRESS	COUNTY	
CITY	STATE	ZIP CODE
QUESTIONNAIRE COMPLETED BY - NAME	TITLE	
PLANT ADDRESS, IF DIFFERENT		DATE

PART I. GENERAL INFORMATION

A. PLANT CLASSIFICATION

1. PROCESSES CONDUCTED AT THIS PLANT:
(check appropriate categories)
____ CANNING
____ FREEZING
____ DEHYDRATING
____ OTHER ____________ (specify)

2. USE OF LAND IN IMMEDIATE VICINITY OF PLANT: (check predominant use only)
____ AGRICULTURAL
____ INDUSTRIAL
____ COMMERCIAL
____ RESIDENTIAL
____ OTHER ____________ (specify)
DISTANCE TO NEAREST RESIDENTIAL DEVELOPMENT: ____ MILES

3. HOW LONG HAS THE PLANT BEEN LOCATED AT ITS PRESENT SITE?
________ YEARS

4. WHEN WAS THE LAST MAJOR PLANT EXPANSION COMPLETED?
(State year) ________

5. ARE PLANS CURRENTLY BEING CONSIDERED FOR EXPANDING, REDUCING THE SIZE OF THIS PLANT? PLANS FOR RELOCATING?
____ EXPAND
____ REDUCE
____ RELOCATE
____ NO PLANS
IF CHANGING, GIVE APPROXIMATE PERCENTAGE CHANGE IN SIZE OF EXISTING OR NEW PLANT. ________

6. ARE PLANS CURRENTLY BEING CONSIDERED FOR INCREASING OR CURTAILING PRODUCTION IN THIS PLANT IN THE NEAR FUTURE?
____ INCREASE
____ DECREASE
____ NO PLANS
APPROXIMATE PERCENTAGE CHANGE, IF ANY ________
YEAR OF CHANGE ________

B. RAW PRODUCTS PROCESSED BY THIS PLANT

INSTRUCTIONS: Indicate, under the appropriate months, the total WEIGHT of each raw product received by this plant each month of the last completed season. Also for each product, indicate in the appropriate columns the maximum TONS PER HOUR processed, the average number of operating DAYS PER SEASON, and the maximum number of operating HOURS PER DAY.

Please indicate the percent of each raw product utilized (YIELD).

WEIGHT EXPRESSED IN: (Check one) TONS _____ POUNDS _____

FIGURES BASED ON: (Check one) RECORDS _____ ESTIMATES _____

No.	PRODUCT	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	TONS PER HR.	DAYS PER SEAS.	HRS. PER DAY	YIELD %
1																	
2																	
3																	
4																	
5																	
6																	
7																	
8																	
9																	
10																	

Attach additional page, if necessary

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PART II. SOLID WASTE INFORMATION

A. SOURCES AND DESCRIPTION OF SOLID WASTE MATERIALS

INSTRUCTIONS: Using the number given to each product on page 2, assign a capital letter to each unit operation or process which produces solid waste from that product. Thus, the term "1A" would identify the first operation which produces solid waste from the product listed as "No. 1". Subsequent waste producing operations would be identified by 1B, 1C, etc. Solid waste from other products would be labeled 2A, 2B, ... 3A, etc. If solid wastes originate from sources other than raw products, identify these sources with Roman numerals, beginning with "I". Include all solid waste materials which require disposal (e. g. - scrap lumber, damaged or empty cans, paper, etc.).

Briefly describe the unit operation producing solid waste. Also briefly describe what the solid waste actually is at each source (e. g. - peach pits, undersized peas, corn cobs, etc.).

NOTE: Any material returned to the production line is not to be classified as solid waste.

PRODUCT AND WASTE IDENTIFICATION NUMBER	OPERATION OR PROCESS PRODUCING SOLID WASTE	BRIEF DESCRIPTION OF WASTE MATERIAL
1A		
1B		
1C		

Continue on next page

A. SOURCES AND DESCRIPTION OF SOLID WASTE MATERIALS

Continued from page 3.

PRODUCT AND WASTE IDENTIFICATION	OPERATION OR PROCESS PRODUCING SOLID WASTE	BRIEF DESCRIPTION OF WASTE MATERIAL

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B. IN-PLANT WASTE HANDLING SYSTEMS

INSTRUCTIONS: Use the product and waste identification numbers listed on pages 3 and 4. Check the method used within the plant to handle solid waste from each of these sources. If combination systems are employed, check all appropriate items.

DRY CONTINUOUS waste handling systems include belt and screw conveyors, elevators, etc.
WET CONTINUOUS systems include flumes, gutters, transport pipes.
CONTAINERS - buckets, barrels, bins, portable hoppers, etc.

Also indicate how the waste from each source is handled.

BY-PRODUCT MANUFACTURE includes all forms of utilization -- animal feed, charcoal production, alcohol production, etc. -- regardless of whether such utilization is by this company or another party.
DISCARDED material includes all solid wastes disposed of by landfill, incineration, or other non-productive method.

PRODUCT AND WASTE IDENTIFICATION NUMBER	IN-PLANT HANDLING SYSTEM (Check or specify)				USE OF WASTE MATERIAL FROM EACH SOURCE (Check appropriate use)	
	CONTINUOUS		CON-TAINERS	OTHER (Specify)	BY-PRODUCT MANUFACTURE	DISCARDED
	DRY	WET				
1A						
1B						
1C						

Continue on next page.

B. IN-PLANT WASTE HANDLING SYSTEMS

Continued from page 5.

PRODUCT AND WASTE ID. NUMBER	IN-PLANT HANDLING SYSTEM (Check appropriate methods)				USE OF WASTE MATERIAL FROM EACH SOURCE: (Check appropriate use)	
	CONTINUOUS		CONTAINERS	OTHER (Specify)	BY PRODUCT MANUFACTURE	DISCARDED
	WET	DRY				

Attach additional page, if necessary

C. QUANTITY OF SOLID WASTE AND CURRENT METHOD OF DISPOSAL

INSTRUCTIONS: State the yearly total quantity of solid waste produced from each raw product--use the product numbers from page 2. Also include all solid waste originating from sources other than raw products--use the Roman numerals from pages 3 and 4 if applicable, or classify as "other" Indicate whether the units of quantity are expressed in tons or cubic yards and whether these are based on records or estimates.

Enter the percentage of each waste material which is screened, if applicable.

Enter the percentage of each waste material disposed of by each method. These should horizontally total 100%. Also enter the percent hauled from the plant by each collector. These should also total 100%.

PRODUCT OR WASTE NUMBER	QUANTITY (See note below)	BASIS (Check one)		PERCENT SCREENED	METHOD OF DISPOSAL (State % disposed of by each method)									PERCENT HAULED BY EACH TYPE OF COLLECTOR		
	TONS / YR. CU. YDS / YR. (check one)	RECORDS	ESTIMATES		LAND FILL	SPREAD ON LAND	INCINERATION	ANIMAL FEED	CHARCOAL	ALCOHOL PRODUCT N	COMPOST ING	OTHER		SELF	PRIVATE COLLECTOR	PUBLIC COLLECTOR
												%	METHOD			

NOTE: If units of solid waste are expressed in cubic yards, please list conversion factors (to obtain tons) for each product, if these factors are known.

CONVERSION FACTORS:

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D. ON-SITE HANDLING

1. IS ANY SOLID WASTE MATERIAL DISCHARGED FROM THE PLANT WITH THE LIQUID WASTE EFFLUENT?

___ YES If yes, complete item 5.
___ NO

2. ARE FACILITIES PROVIDED FOR SOLID-LIQUID SEPARATION?

___ YES
___ NO

If yes, complete items 3 and 4 below.

3. METHOD OF SOLID-LIQUID SEPARATION:

___ SCREENING

If solid-liquid separation method other than screening is used, briefly describe - (e. g. - setting basin, etc).

____
____
____
____

4. If screens are employed, check all appropriate items below.

TYPE	MESH	
___ STATIC	___ 10	___ 40
___ VIBRATING	___ 20	___ 50
___ REVOLVING	___ 30	___ ________ (Specify)
___ MESH BELT		
___ OTHER ________ (Specify)		

5. If solid waste material is discharged with the plant liquid effluent, describe method of handing and disposal.

(a.) STATE IN WHICH SOLID WASTE MATERIAL IS DISCHARGED:

___ WITHOUT TREATMENT
___ AFTER COMMINUTION
___ OTHER ____________ (Describe)

(b.) WHAT PORTION OF SOLID WASTES ARE SO HANDLED?

(c.) PLACE OF DISPOSAL OF LIQUID WASTE CONTAINING SOLID MATERIAL.

___ STREAM, LAKE, OCEAN, BAY
___ SEWAGE TREATMENT PLANT
___ LAGOON, POND
___ IRRIGATION
___ OTHER ____________ (Specify)

6. IS INCINERATION CONDUCTED AT THIS PLANT?

___ YES If yes, complete
___ NO item 7.

7. METHOD OF INCINERATION: (Check appropriate items)

___ OPEN BURNING
___ FURNACE
___ OTHER ____________ (Specify)

FREQUENCY OF BURNING:

___ CONTINUOUS
___ PERIODIC ____________ (Specify)

8. WHAT IS THE TOTAL ANNUAL OUT-OF-POCKET EXPENSES INCURRED BY THIS PLANT FOR SOLID WASTE HAULING?

$__________ PER YR.

9. WHAT METHODS ARE USED FOR ACCUMULATING AND STORING SOLID WASTE MATERIAL TO BE HAULED FROM THE PLANT? (Check all appropriate items)

_____ STOCK PILING
_____ BARRELS, BINS, ETC.
_____ PERMANENT HOPPER
_____ OTHER (Specify) __________________

10. ON- SITE STORAGE FACILITIES. The following questions are in regard to solid waste storage facilities located on the site of the plant. Place a check in the appropriate column. Indicate under COMMENTS the products with which the problems are associated, the extent of the problem, and solutions, if any, regarding these situations.

PROBLEM	OCCURRENCE			COMMENTS
	FREQUENTLY	OCCASIONALLY	NEVER	
a. DOES LEACHING (SEPARATION OF LIQUID FROM THE SOLID WASTE) OCCUR DURING STORAGE?				
DOES THIS POSE A PROBLEM?				
b. IS THERE SEEPAGE OF LIQUID FROM THE STORAGE FACILITY?				
IS THIS A PROBLEM?				
c. ARE INSECTS A PROBLEM AT THE STORAGE SITE?				
IS A CONTROL PROGRAM CONDUCTED?				
d. ARE RODENTS A PROBLEM:				
IS A CONTROL PROGRAM CONDUCTED?				
e. HAVE ODOR PROBLEMS BEEN EXPERIENCED AS EVIDENCED BY COMPLAINTS?				ORIGIN OF COMPLAINT-- SOLUTIONS?--

E. DISPOSAL SITE INFORMATION

INSTRUCTIONS: Complete the appropriate sections on pages 10 and 11 pertaining to the methods used for disposal of solid waste material from this plant. If the solid wastes are hauled from the plant by a private or public collector, determine the method of disposal used by the collector and complete information requested in this section.

Continued on next page.

INSTRUCTIONS (cont'd.): State the annual cost incurred by the plant for use of each disposal site. If such costs are included in the hauling fees listed on page 8, so indicate wherever costs are requested.

LAND FILL

1. DISTANCE FROM PLANT TO SITE:

____ MILES

2. SIZE OF FILL SITE:

____ ACRES

3. SITE OWNED BY: (Check one)
   - ____ COMPANY
   - ____ OTHER PRIVATE
   - ____ PUBLIC

4. SITE OPERATED BY: (Check one)
   - ____ COMPANY
   - ____ OTHER PRIVATE
   - ____ PUBLIC
   - ____ ____

5. DESCRIPTION OF SITE: (Check one)
   - ____ QUARRY, PIT
   - ____ GULLY, CANYON
   - ____ LEVEL GROUND
   - ____ MARSH, TIDELAND
   - ____ OTHER (Specify) ____

6. USE OF DISPOSAL SITE:
   - ____ WASTE FROM THIS PLANT ONLY
   - ____ GARBAGE
   - ____ INDUSTRIAL REFUSE
   - ____ DOMESTIC REFUSE OTHER THAN GARBAGE
   - ____ OTHER ____

7. FREQUENCY OF DISCHARGE AT DISPOSAL SITE:

____ TIMES PER DAY

8. FREQUENCY OF COVERING AT SITE:
   - ____ IMMEDIATE
   - ____ DAILY
   - ____ ____

9. ANNUAL COST TO COMPANY FOR USE OF SITE, IF SEPARATE:

$____

10. ENVIRONMENTAL PROBLEMS AT SITE: (Check all appropriate items)
    - ____ INSECTS
    - ____ RODENTS
    - ____ ODORS
    - ____ WATER POLLUTION
    - ____ OTHER (Specify) ____

SPREAD ON LAND

1. DISTANCE FROM PLANT TO SITE:

____ MILES

2. SIZE OF DISPOSAL AREA:

____ ACRES

3. DESCRIPTION OF LAND USED FOR WASTE DISPOSAL: (Check appropriate items)
   - ____ COMPANY OWNED
   - ____ CITY OWNED
   - ____ AGRICULTURAL
   - ____ WASTELAND
   - ____ OTHER (Specify) ____

4. METHOD OF COVERING:
   - ____ COVER WITH TOP SOIL
   - ____ DISCING INTO SOIL
   - ____ CUT AND BACK-FILL (TRENCHING)

5. ANNUAL COST TO COMPANY FOR USE OF LAND, IF SEPARATE:

$____

Continued on page 11

SPREAD ON LAND

continued from page 10.

6. FREQUENCY OF DISCHARGE AT DISPOSAL SITE:

____ TIMES PER DAY

7. FREQUENCY OF COVERING:

____ IMMEDIATE
____ DAILY
____ OTHER (Specify) ____________

8. ENVIRONMENTAL PROBLEMS:
(Check all appropriate items)

____ INSECTS
____ RODENTS
____ ODORS
____ WATER POLLUTION
____ OTHER (Specify) ____________
____

OTHER DISPOSAL METHODS - INCINERATION, COMPOSTING, ETC. Do not include waste utilization.

1. METHOD OF DISPOSAL:

____
(Specify)

2. DISTANCE FROM PLANT TO DISPOSAL SITE:

____________ MILES

3. SITE OWNED BY:

____ COMPANY
____ OTHER PRIVATE
____ PUBLIC

4. SITE OPERATED BY:

____ COMPANY
____ OTHER PRIVATE
____ PUBLIC

5. ANNUAL COST TO COMPANY FOR USE OF SITE, IF SEPARATE:

$____________

6. USE OF DISPOSAL SITE:

____ WASTE FROM THIS PLANT ONLY
____ GARBAGE
____ INDUSTRIAL REFUSE
____ DOMESTIC REFUSE OTHER THAN GARBAGE
____ OTHER (Specify) ____________
____

7. ENVIRONMENTAL PROBLEMS AT SITE:
(Check all appropriate items)

____ INSECTS
____ RODENTS
____ ODORS
____ WATER POLLUTION
____ OTHER (Specify) ____________
____

8. COMMENTS REGARDING OTHER DISPOSAL METHODS.

C. WASTE UTILIZATION

INSTRUCTIONS: If any solid waste material is used for by-product manufacture as defined on pages 5 and 6, complete the section below. Indicate the costs incurred (preceded by " - ") or returns realized (preceded by "+") by this plant due to utilization of solid waste materials.

WASTE MATERIAL	USE OR BY-PRODUCT	NAME OF UTILIZER	HAULING DISTANCE (MILES)	ANNUAL COST OR RETURNS TO PLANT

PART III COMMENTS

A. RESEARCH NEEDS

DO YOU FEEL MORE RESEARCH SHOULD BE DEVOTED TOWARDS DISPOSAL AND/ OR UTILIZATION OF FOOD PROCESSING WASTES?

____YES
____NO

ARE THERE SPECIFIC AREAS WHICH YOU WOULD LIKE TO HAVE INVESTIGATED?

____YES
____NO

IF YES TO EITHER OR BOTH, PLEASE COMMENT:

____
____
____
____
____

B. OTHER REMARKS:

Any additional information pertinent to this survey and/ or comments regarding this questionnaire would be greatly appreciated. If additional space is required, please attach a separate page.

____
____
____
____
____
____
____
____
____
____

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Site Visit Report Form. This form was used by the project personnel during visits made to selected processing plants. The information entered in these reports was elicited through interviews with appropriate company personnel and by tours through the production facilities, generally during periods of active production.

The reports were normally complete, with the exception of ''Equipment'' and ''Cost'' on page 2. Unit operations which generated solid residuals were often fabricated by the plant mechanics. The age of equipment generally varied widely, resulting in the use of many models for specific operations; thus, cost information was of little value.

The quantities of residuals generated at each unit operation (second column, page 4) were generally difficult to ascertain. For this reason, emphasis was placed solely on the identification of these sources and only incidental quantitative data were developed for specific sources.

Budget Bureau Number: 85-S 69009. Approval Expires December 1970

SOLID WASTE MANAGEMENT IN THE FOOD PROCESSING INDUSTRY

SITE-VISIT REPORT

NCA OFFICE USE ONLY

COMPANY	PLANT
ADDRESS	COUNTY
CITY	STATE ZIP CODE
CONTACT	POSITION
DATE	TIME IN- OUT-
PLANT ADDRESS, IF DIFFERENT	REPORT COMPLETED BY-

PART I. PRODUCTION INFORMATION

A. RAW PRODUCTS UTILIZED

#	PRODUCT	TONS PER HOUR	TONS PER YEAR	UTILIZATION - PERCENT			NUMBER OF STYLES PACKED	OPERATING PERIOD (HRS/DAY)	PERCENT MECHANICAL HARVEST	YIELD %
				CANNED	FROZEN	DEHYDRATION				
1										
2										
3										
4										
5										
6										
7										
8										

B. PLANT CHANGES -

HAS THERE BEEN A SIGNIFICANT INCREASE (+) OR DECREASE (-) IN PLANT PRODUCTION LEVELS RECENTLY?

___CHANGE ____________________

___NO CHANGE (STATE %)

HAVE ANY PROCESSING EQUIPMENT CHANGES BEEN MADE RECENTLY WHICH HAVE ALTERED SOLID WASTE GENERATION?

___YES

___NO

REMARKS: Indicate effects of forementioned changes on solid waste production.

____

____

____

____

____

____

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PAGE 1 OF 6

PART II. SOLID WASTE INFORMATION

A. UNIT OPERATION EQUIPMENT

PRODUCT & WASTE ID.	OPERATION	EQUIPMENT (make and model)	COST

B. SCHEMATIC DIAGRAM OF PRODUCT FLOW, SOLID WASTE SOURCES, AND IN-PLANT HANDLING PROCEDURES

PRODUCTS INCLUDED IN SCHEME BELOW:

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C. QUANTITY OF SOLID WASTE

PRODUCT AND WASTE ID	QUANTITY ___ TONS / ___ CU. YDS. /	BASIS		ULTIMATE COLLECTION AND STORAGE SITE (see below)						IN-PLANT HANDLING SYSTEM			
		RECORDS	ESTIMATES	1	2	3	4	5	6	CONT.		CONTAINER	OTHER (specify)
										DRY	WET		

D. ULTIMATE ON-SITE COLLECTION AND STORAGE FACILITIES

SITE	DESCRIPTION	YEAR INSTALLED	CAPITAL AND INSTALLATION COSTS	OPERATING AND MAINTENANCE COSTS
1				
2				
3				
4				
5				
6				

E. DISPOSITION OF SOLID WASTE FROM STORAGE SITES

SITE	METHOD OF DISPOSITION (Check or specify all appropriate items)							HAULER			FREQUENCY OF HAULING
	LAND FILL	SPREAD ON LAND	INCINERATE	ANIMAL FEED	CHARCOAL	ALCOHOL PRODUCTION	OTHER (specify)	SELF	PRIVATE	PUBLIC	
1											
2											
3											
4											
5											
6											

F. SCHEMATIC DIAGRAM OF SOLID WASTE COLLECTION AND STORAGE FACILITIES

G. SCHEMATIC DIAGRAM OF ON-SITE DISPOSAL/UTILIZATION FACILITIES

NOTES AND COMMENTS

Coverage. The geographic distribution of the questionnaire returns and the geographic and product class coverage achieved during the site visit phase of the program are summarized in Table A4.

TABLE A4
QUESTIONNAIRE AND SITE VISIT COVERAGE

	New Eng.	Mid Atl.	South Atl.	North Cent.	South Cent.	Mount-ain	North West	South West	Alas-ka	Total
Question-naires Received	14	43	36	109	19	11	74	93	22	421
Plants Visited	2	35	26	38	11	10	44	59	4	229
Vegetable	0	25	17	29	7	10	41	36	0	165
Fruit	0	8	8	9	1	1	16	33	0	76
Misc.	0	5	3	0	0	0	0	2	0	10
Seafood	2	0	0	0	3	0	2	3	4	14

APPENDIX D

DEFINITION OF TERMS

bin	a container, generally with a half ton capacity, constructed of wood or metal and used to transport product from the field to the processing plant; also frequently used to accumulate and transport residuals. The most commonly used bin has approximate dimensions of 4' x 4' x 2' (depth).
blancher	processing equipment serving one or more of several functions, including destruction of oxidative enzymes, removal of gases from product, and preservation of certain desirable characteristics inherent to fresh produce (color, flavor, texture, etc.). Blanchers in common use utilize either steam or hot water, or a combination of the two, to heat the product to the required blanching temperature.
box	commonly modified by field-, tote-, or lug-. A container, generally with a 40 to 50 pounds capacity, constructed of wood and used to transport product from the field to the processing plant; also frequently used to accumulate and transport residuals within the plant.
cull	a fruit or vegetable which is unacceptable for processing due to immaturity, discoloration, presence of blemishes, or other reasons.
exhaust box	processing equipment, generally a steam chamber or tunnel, through which cans filled with product and brine or syrup are passed to remove entrapped air and gases prior to sealing of the cans.
filler	equipment utilized to place product into containers. Fillers may automatically perform this function (such as piston or tumbler fillers) or may serve to assist manual placement of product into cans or cartons (such as trough or table fillers).
finisher	processing equipment used to reduce raw product to a puree of desired texture and consistency by forced passage through fine-mesh screens. Fibers and coarse particles are generally discharged from the unit as residual material.
hopper	device for the temporary storage of product or residual materials. Permanent hoppers, as used in this report, are large elevated structures in which residuals are accumulated and stored. Portable hoppers are moveable metal containers also used for

residuals accumulation and storage. Materials in both are periodically emptied into waste hauling trucks for appropriate disposition.

in-plant	used in this report to describe operations and activities conducted within the confines of the processing plant, generally within the building proper (intramural).
non-food	materials other than from food products accumulated at the processing plant; including wooden boxes, paper and plastic wrappers, cardboard containers and dividers, metal cans and straps, glass jars, and the like.
on-site	used in this report to describe operations and activities conducted on the property of the processing plant but generally outside (extramural) of the processing area itself.
product	aside from its ordinary meaning, ‘‘product’’ is used in this report interchangeably with ‘‘commodity’’ (apple, apricot, asparagus, etc.).
pulper	processing equipment used to reduce raw product to a coarse slurry by forced passage through screens or sieves. Stems, pits, and other coarse particles are separated from the product which is then normally passed through a finisher.
raw tons	tons of raw product delivered to a processor. The weight includes only those inedible parts (husks, cobs, shells, etc.) which are normally so delivered; pea pods, for example, are normally left in the field and not included in the delivered weight.
residual	material left over from processing a primary product; a reused solid residual is called a by-product; a wasted solid residual is called a solid waste. The term applies to non-food as well as to food materials.
retort	processing equipment used to sterilize and thereby preserve the contents in sealed cans. Retorts are designed to accomodate batch lots of cans; ‘‘cookers’’ accept and process cans continuously. Both are operated with saturated steam, generally under pressure.
seamer	also called a can-closing machine; a device which mechanically attaches the lid onto metal cans, thereby creating an air-tight container. Some models perform this function under partial vacuum, thus imparting a negative pressure to the can contents

	(for other models, the vacuum is obtained by preheating the product or head-space gas).
size grader	a mechanical device used to separate a product stream into several size categories. Commonly used size graders consist of divergently-spaced rollers or belts, or revolving cylinders or vibrating tables perforated with increasingly larger openings.
specialty	in this report, a composite formulated from several commodities, often repacked from previously processed ingredients; examples: soup, baby food, frozen dinner.

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